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STILLWATER RANGE G-E-M

RESOURCES AREA

(GRA NO. NV-04)

TECHNICAL REPORT

(WSAs NV 030-104 and 030-127)

Contract YA-554-RFP2-1054

Prepared By

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For

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Final Report

May 6, 1983

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CLAIM AND LEASE MAPS (Attached)

Patented/Unpatented

Oil and Gas

Geothermal

Sodium

MINERAL OCCURRENCE AND LAND CLASSIFICATION MAPS (Attached)

Metallic Minerals

Uranium and Thorium

Nonmetallic Minerals

Oil and Gas

Geothermal

Level of Confidence Scheme

Classification Scheme

Major Stratigraphic and Time Divisions in Use by the U. S. Geological Survey

EXECUTIVE SUMMARY

The Stillwater Range Geology-Energy-Minerals (GEM) Resource Area (GRA) includes the following Wilderness Study Areas (WSAs): NV 030-104 and NV 030-127. The GRA is located in central Churchill County in west-central Nevada. The two WSAs include a large portion of the Stillwater Range which is a typical block faulted range of the Basin and Range province. The range is very complex and contains 130 to 225 million year old sediments and volcanics intruded by both granitic and gabbroic intrusives. Overlying them all are younger volcanics.

There are eight mining districts in the GRA: Copper Kettle, White Cloud, Shady Run, Cox Canyon, Corral Canyon, Dixie Valley, I.X.L. and Mountain Wells. Production has included copper, gold, silver, mercury, tungsten and fluorite. Total production from all the districts, however, probably does not exceed one million dollars. Five of the districts are at least partially within WSA NV 030-104. The White Cloud district falls completely inside the WSA.

Patented claims are found in some of the above described mining districts. One large patented claim group covering perhaps a square mile lies completely within WSA NV 030-104 in the White Cloud district. Additional patented claims lie within the same WSA near the Dixie Valley district.

Unpatented claims in the GRA literally number in the hundreds. Most are concentrated in the vicinity of the eight mining districts but at least two large blocks of claims are outside the districts. Hundreds of these claims are within the boundaries of both WSAs. The majority of the west side of the mountain range from Copper Kettle Canyon in the north to Table Mountain in the south appears to be covered by mining claims. Oil and gas leases cover nearly all of the GRA underlain by the valley alluvium and a portion of the mountains as well. Geothermal leases cover most of Dixie Valley and portions of Carson Sink as well.

The Stillwater Range including both WSAs are considered to have a high to moderate favorability for metallic mineral resources with a high to moderate confidence level. This is because of the presence of known mineralization, favorable geologic environment, and the preponderance of interest in the area in the form of exploration activity and unpatented claims. The areas of higher favorability are in the vicinity of the eight mining districts that are found in close proximity to the two WSAs. This GRA is considered one of the more favorable of environments for metallic mineral potential of all the GRA's studied in the Basin and Range province during this investigation. Metallic mineral commodities of interest and having potential include: gold, silver, copper, tungsten, mercury, iron and molybdenum.

Both WSAs have low favorability for uranium with a low confidence level, and low favorability for thorium with a very low confidence level.

Nonmetallic mineral potential is considered to have a low favorability with a low confidence level for most of the area based on available information. There is potential for additional fluorite in the Cox Canyon, Shady Run and White Cloud districts. Sand and gravel in the areas covered by alluvium has moderate favorbility with a moderate confidence level. There is a moderate favorability for oil and gas based on the leasing, exploration activity and the possible existing sections in the valleys. There is no indication of favorability in the mountain areas. Known geothermal deposits are present and the entire region is very prospective. The favorability rating is high to moderate for geothermal, with the former rating being in range front and valley areas.

Recommendations to further evaluate mineral potential include detailed geologic mapping of the WSAs and mining districts, further investigation of claims and further input from claim holders.

I. INTRODUCTION

The Stillwater Range G-E-M Resources Area (GRA No. NV-04) contains approximately 400,000 acres (1,600 sq km) and includes the following Wilderness Study Areas (WSAs):

WSA Name	WSA Number
Stillwater Range	NV 030-104
Job Peak	NV 030-127

The GRA is located in Nevada within the Bureau of Land Management's (BLM) Lahontan Resource Area, Carson City district. Figure 1 is an index map showing the location of the GRA. The area encompassed is near 39°45' north latitude, 118°15' west longitude and includes the following townships:

T 24 N, R 33-36 E	T 20 N, R 32-34 E
T 23 N, R 33-35 E	T 19 N, R 32-34 E
T 22 N, R 33-35 E	T 18 N, R 32-34 E
T 21 N, R 33,34 E	

The areas of the WSAs are on the following U. S. Geological Survey topographic maps:

15-minute:

Dixie Hot Springs

7.5-minute:

Lone Rock, SE	Cox Canyon
IXL Canyon	Foxtail Lake
Table Mountain	Job Peak
Dixie Valley, SE(?)	LaPlata Canyon(?)
Pirouette Mountain	

The nearest town is Stillwater which is located about five miles west of the western GRA border along State Route 42. Access to the area is via unimproved light duty and dirt roads to the west, north and east, and U. S. Highway 50 to the south. Access within the area is via unimproved light duty and dirt roads scattered throughout the GRA, with some penetrating the WSA.

Figure 2 outlines the boundaries of the GRA and the WSAs on a topographic base at a scale of 1:250,000.

Figure 3 is a geologic map of the GRA and vicinity, also at 1:250,000. At the end of the report, following the Land Classification Maps, is a geologic time scale showing the various geologic eras, periods and epochs by name as they are used in the text, with the corresponding age in years. This is so that the reader who is not familiar with geologic time subdivisions will have a comprehensive reference for the geochronology of events.

This GRA Report is one of fifty-five reports on the Geology-Energy-Minerals potential of Wilderness Study Areas in the Basin and Range province, prepared for the Bureau of Land Management by the Great Basin GEM Joint Venture.

The principals of the Venture are Arthur Baker III, G. Martin Booth III, and Dennis P. Bryan. The study is principally a literature search supplemented by information provided by claim owners, other individuals with knowledge of some areas, and both specific and general experience of the authors. Brief field verification work was conducted on approximately 25 percent of the WSAs coveredy by the study.

None of the WSAs in this GRA were field checked.

One original copy of background data specifically applicable to this GEM Resource Area Report has been provided to the BLM as the GRA File. In the GRA File are items such as letters from or notes on telephone conversations with claim owners in the GRA or the WSA, plots of areas of Land Classification for Mineral Resources on maps at a larger scale than those that accompany this report if such were made, original compilations of mining claim distribution, any copies of journal articles or other documents that were acquired during the research, and other notes as are deemed applicable by the authors.

As part of the contract that resulted in this report, a background document was also written: Geological Environments of Energy and Mineral Resources. A copy of this document is included in the GRA File to this GRA report. There are some geological environments that are known to be favorable for certain kinds of mineral deposits, while other environments are known to be much less favorable. In many instances conclusions as to the favorability of areas for the accumulation of mineral resources, drawn in these GRA Reports, have been influenced by the geology of the areas, regardless of whether occurrences of valuable minerals are known to be present. This document is provided to give the reader some understanding of at least the most important aspects of geological environments that were in the minds of the authors when they wrote these reports.

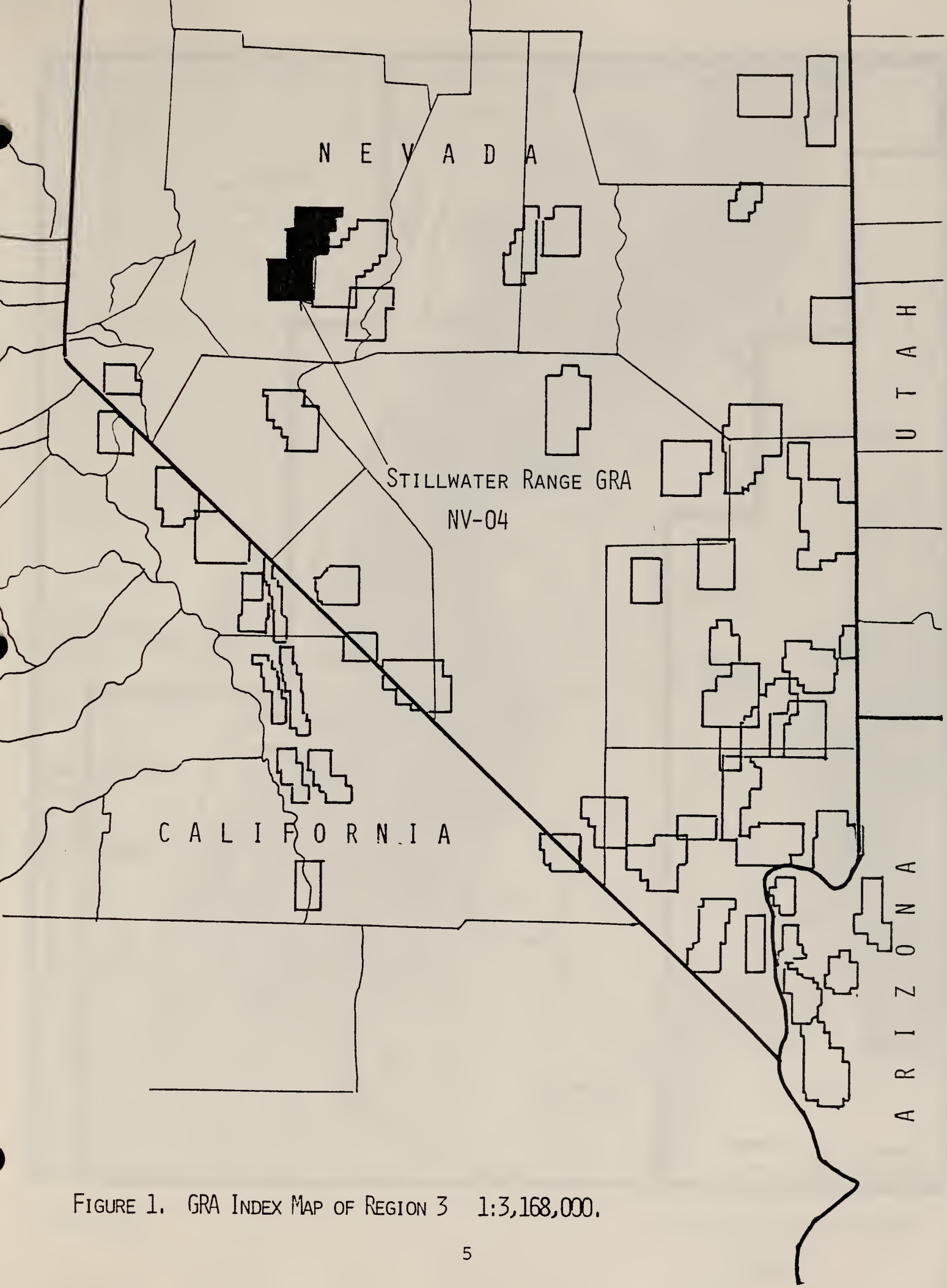
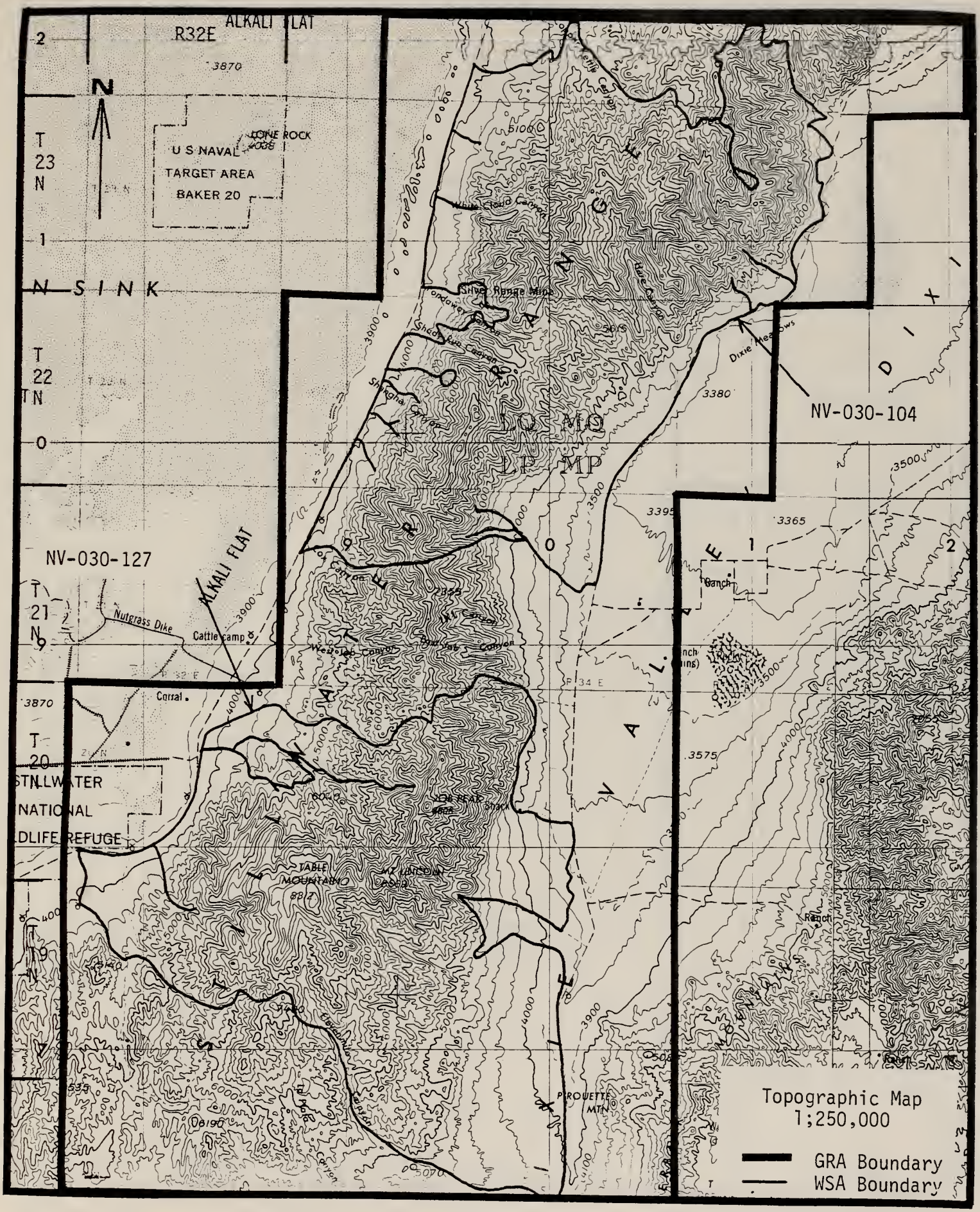


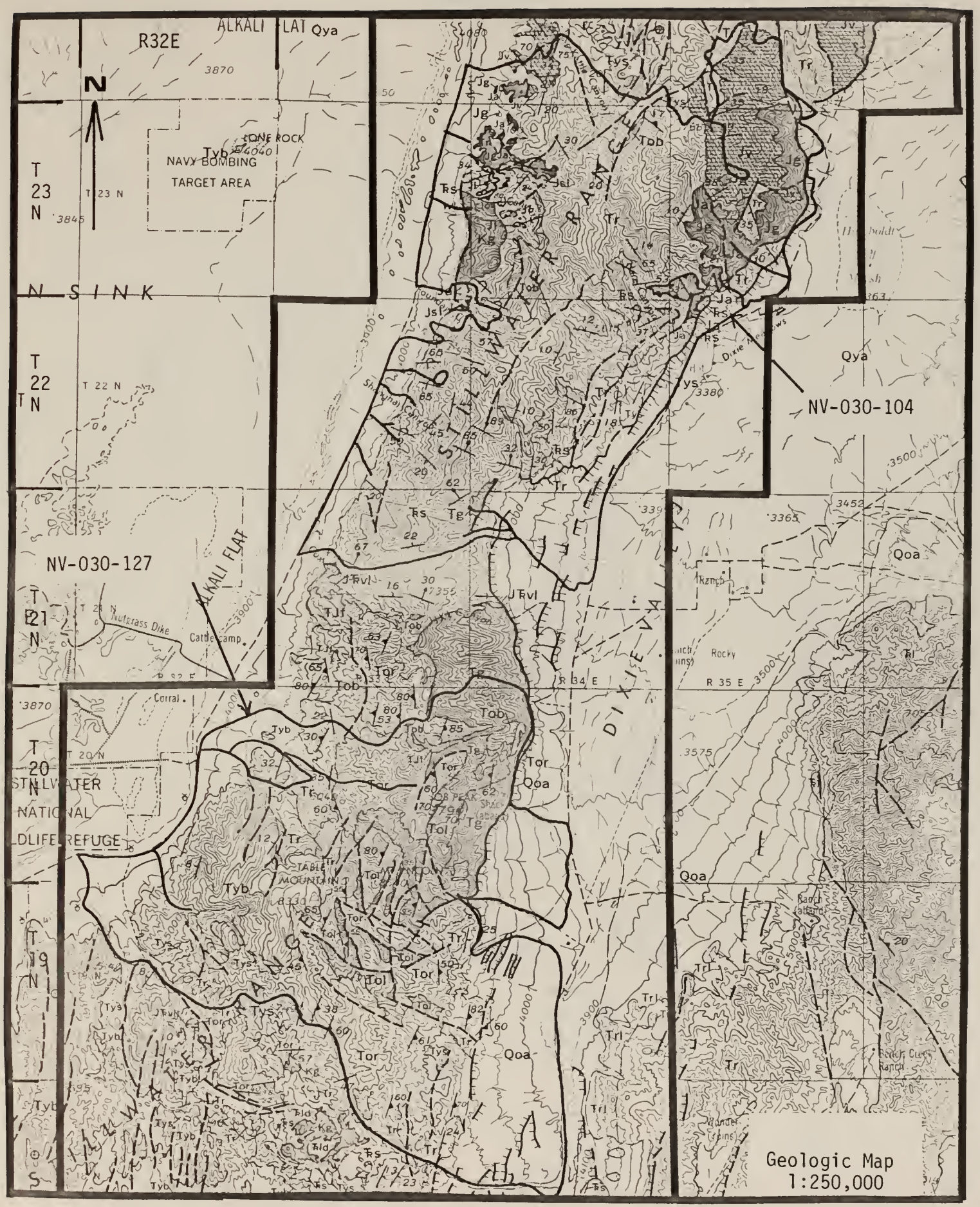
FIGURE 1. GRA INDEX MAP OF REGION 3 1:3,168,000.



Reno Sheet

Stillwater Range GRA NV-04

Figure 2



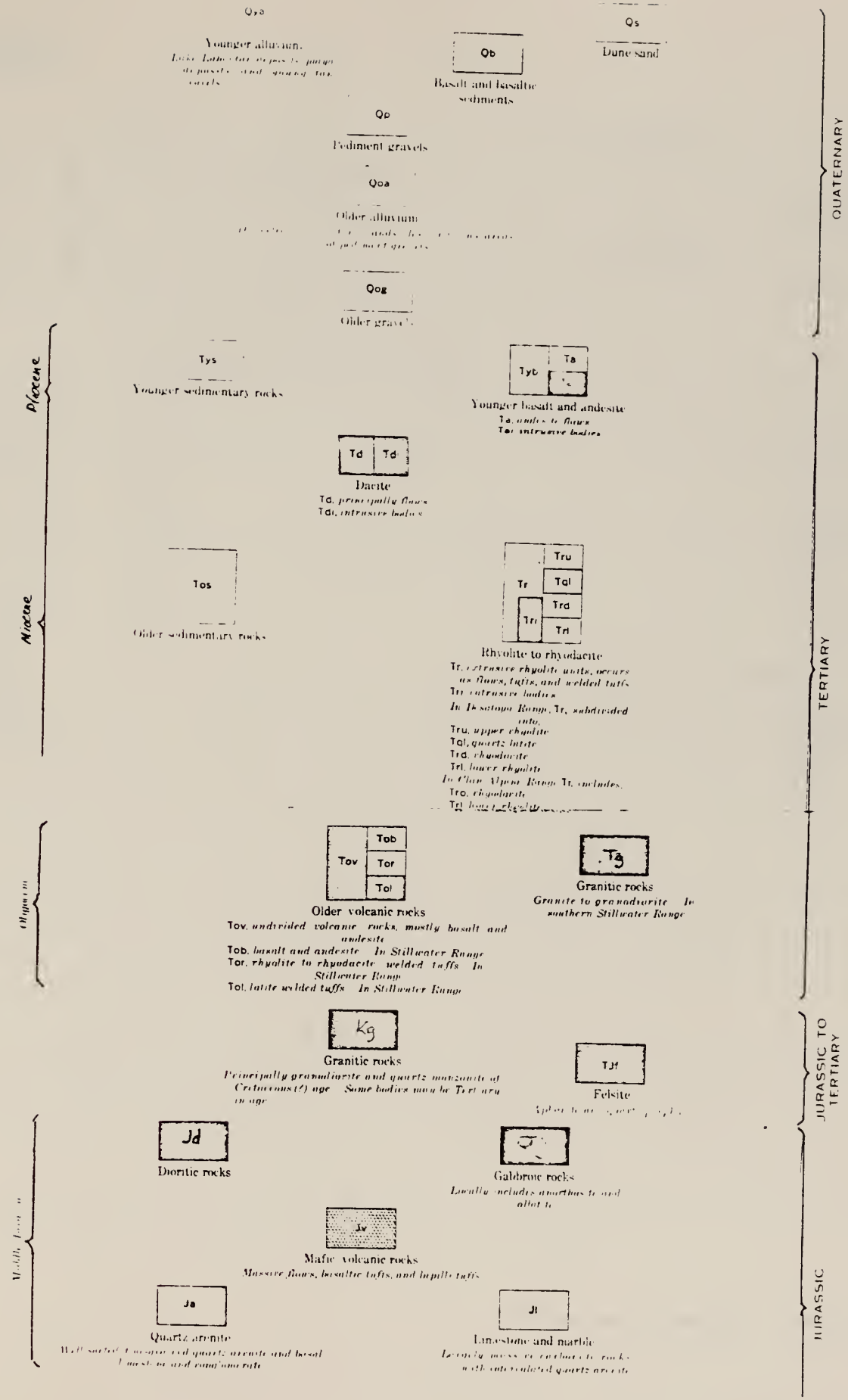
Willden and Speed (1974)

See next page for explanation

Stillwater Range GRA NV-04

Figure 3

EXPLANATION



CHIEFLY IN NORTHWEST PART OF COUNTY BUT ALSO IN DESATOYA RANGE AND IN SOUTHWEST PART

TRIASSIC AND (OR) JURASSIC

JTls — Limestone and marble

JTph — Hornfels, phyllite, and schist

JTmv — Metavolcanic rocks

Upper Triassic to Middle Jurassic

JTvl / ls — Volcaniclastic rocks and limestone
ls, limestone

Upper Triassic

Shale and siltstone

Middle Triassic

Lower(?) and Middle Triassic

Contact
Dashed where approximately located, dotted where concealed

High angle fault, showing dip
Dashed where approximately located, dotted where concealed. Hachures on downthrown side of fault traces

Thrust fault
Dashed where approximately located, dotted where concealed, sawteeth on upper plate

30 Inclined — 65 Overturned — 40 Top of beds

Horizontal — Vertical
Strike and dip of beds

65
Strike and dip of foliation

65
Bearing and plunge of lineation
May be combined with other symbols

Lower Jurassic

Jsl — Calcareous siltstone and limestone
Includes minor amount of shale

Trld — Limestone and dolomite

AUGUSTA MOUNTAINS

To — Osobb Formation

Tcs — Cane Spring Formation

Ta — Augusta Mountain Formation

Tf — Favret Formation

Tc — Conglomerate

TPsv — Sedimentary and volcanic rocks

Pc — Chert and clastic and volcanic rocks

TRIASSIC

PALEOZOIC

II. GEOLOGY

The Stillwater Range GRA lies within the Basin and Range province in central Churchill County, Nevada. The study area includes a central portion of the Stillwater Range, a northeast-trending horst bounded by high-angle faults of large vertical displacement.

Rock units (see Figure 3) in the area consist of deformed Mesozoic sediments, mafic igneous rocks and intrusions, and Cenozoic sediments, volcanics and intrusives.

The structure in the Stillwater Range is complex. Several orogenic events have produced thrust faults, normal faults and folding of the Mesozoic and Tertiary rocks. The Basin and Range type normal faults, especially on the eastern flanks have been recently active. Movement along these faults were associated with large earthquakes in 1954.

Most of the following geological description is taken from either Willden and Speed, 1974 or Page, 1965.

1. PHYSIOGRAPHY

The Stillwater Range GRA lies within the Basin and Range province in central Churchill County, Nevada. The study area includes two WSAs in the northeast-trending Stillwater Range. NV 030-104 is in the northern part and contains the area between Copper Kettle Canyon and Cox Canyon. NV 030-127, the southern area, lies between Elevenmile Canyon on the south and Poco Canyon on the north.

The Stillwater Range is a horst bounded by high-angle faults of large vertical displacement. Rocks in the study area include several units of deformed Mesozoic rocks separated by thrust faults, mafic igneous rocks, and a sequence of volcanic and sedimentary rocks of probable Cenozoic age.

The topography is rugged with elevations along the crest of the range averaging about 6,500 feet. The Carson sink, on the west side of the range is approximately 3,900 feet in elevation and Dixie Valley bounding the east side of the range is about 3,500 feet.

Drainage at the Stillwater Range is internal with the western flank streams discharging into the Carson sink and the eastern flank streams draining into Dixie Valley.

2. ROCK UNITS

The oldest rock unit in the Stillwater Range GRA is a Late Triassic, undivided sequence of shale, sandstone, and siltstone. Deposited next was a series of volcanic clastic

rocks with abundant lithic fragments of andesite, quartz siltstone and discrete feldspar crystals (Willden and Speed, 1974). A Middle Jurassic quartz arenite with basal limestone and dolomite conglomerate is the next youngest rock unit. Deposited next was a series of mafic volcanic rocks chiefly of basaltic composition. They occur as lapilli tuff, finely layered tuff, bedded agglomerate, tuff breccia and lava. A large complex of Middle Jurassic gabbroic rocks in the form of an elliptical lopolith is the next youngest rock unit. The gabbro intrudes the quartz arenite and comagmatic basaltic rocks (Speed, 1966).

Felsite consisting of colorless porphyro-aphanitic intrusive rocks was emplaced in Jurassic to Tertiary time. It occurs in large bodies near Cox Canyon and Job Peak. A granite body which covers about four square miles in the White Cloud Canyon area was emplaced next in Post-Middle Jurassic time (Young, 1963).

An Oligocene basal volcanic sequence consisting of latite, rhyolite to rhyodacite welded tuffs, and basalt and andesite flows is the next youngest rock unit in the study area. These sub units have been described in detail by Page (1965).

Two granitic plutons on the east side of the Stillwater Range are the only intrusives in Churchill County assigned a Tertiary age. These rocks are granodiorite and quartz monzonite in composition and have been radiometrically dated at 28 $\pm$ 2.0 m.y. (Page, 1965).

Extrusive Miocene rhyolite occurring as flows, tuffs and welded tuffs rests unconformably on the older units. This formation covers a large portion of WSA NV 030-104.

A Pliocene basalt unit, mostly composed of olivine basalt, is the youngest volcanic unit in the study area. Outcrops of this formation are found in both the northern and southern portions of the GRA.

There are also accumulations of Pliocene sedimentary rocks consisting of poorly consolidated sands and gravels, clays, shales, and light colored tuffs. The Tertiary sediments in the Stillwater Range are both fluvial and lacustrine and probably include Miocene and Pliocene deposits (Page, 1965).

3. STRUCTURAL GEOLOGY AND TECTONICS

The oldest structural features found in the Stillwater Range GRA are mainly folds and thrusts produced by an orogeny that probably began in Middle Jurassic time. The first deformation produced folds trending west to northwest. They are doubly plunging with magnitudes generally less than 40°.

The Cox Canyon thrust zone, on the east flank of the Stillwater Range, is another important Mesozoic structure (Page, 1965). It brings upper Triassic siltstone over Triassic and Jurassic volcanic sedimentary rocks, conglomerate, carbonate rocks and quartz arenite. Part of the contact zone is marked by discordance and brecciation (Page, 1965) however, Willden and Speed (1974) suggest that this fault is only a local occurrence and that in other areas the units are in depositional continuity.

The emplacement of the Middle Jurassic gabbro caused the intruded arenite and overlying mafic volcanic rocks to be thrust radially from the magmatic source (Speed and Page, 1964). Where the quartz arenite is invaded by gabbro, its base is a thrust, and the fault is not folded with the rocks below; and where the arenite is not associated with gabbro it is autochthonous and is infolded with the sub-adjacent terrain.

Sometime between the Middle Jurassic to Miocene time a second phase of folding of much larger wavelength deformed the previously deformed structures about a north-trending axes. North-trending folds involving Cenozoic volcanic and sedimentary rocks in the Stillwater Range have been mapped and described by Page (1965).

Late Tertiary high-angle normal faults of the Basin and Range type generally have a northerly trend and are largely responsible for the present day topography. Faults along the eastern flank of the Stillwater Range and in Dixie Valley are seismically active today and generated large earthquakes in 1954 which faulted leaving large scarps on the east flank of the range (Romney, 1957; Slemmons, 1957).

4. PALEONTOLOGY

The principal fossiliferous strata within the Stillwater Range GRA are carbonates and clastic units assignable to the Luning and Dunlap Formations, containing a marine invertebrate fauna dominated by ammonites (Mollusca: Cephalopoda). Frequent occurrence of icthyosaurs (Vertebrata: Reptilia: Parapsida) from unrecorded localities have been reported by residents of the area, although they have not been confirmed by this author. It is not unusual to encounter icthyosaur remains in almost any lithofacies of the Luning Formation, although they are usually isolated fragments. Late Triassic ammonites (Tropites Sp.) have been reported from float in Shanghi Canyon, on the west side of the Stillwater Range, although no locality is recorded of their occurrence in sites. That part of the GRA characterized by Triassic and lowermost Jurassic (Hettangian) marine sediments should be considered as having a relatively high potential for both invertebrate and vertebrate (i.e. icthyosaur) paleontological resources.

Page (1965) reports leaf and wood fossils from the Tertiary non-marine sediments in the Stillwaters, but very little of this is exposed in the two WSAs in the GRA.

5. HISTORICAL GEOLOGY

Because the oldest rocks in the study area are Late Triassic in age, the effects of Paleozoic tectonism are largely unknown. These Late Triassic clastic sediments were probably derived from eroding highlands formed during the Paleozoic orogenic events.

During the Mesozoic at least two tectonic events folded sediments and igneous rocks that had been previously deposited. Westerly-trending folds were formed by the Middle Jurassic tectonic event. The quartz arenite was deposited during the early stages of folding and is synorogenic. Volcanism was also active at this time and a series of volcaniclastic rocks was deposited.

Northerly-trending folds of broader wavelength were produced by a second phase of folding sometime between mid-Jurassic and Miocene time. Intraformational thrusts associated with the early phase of folding are common in the Triassic and Lower Jurassic rocks.

The emplacement of the Middle Jurassic gabbro caused the intruded parts of the arenite and the overlying mafic volcanic rocks to be thrust radially away from the magmatic source.

Granitic intrusive bodies were emplaced in post Middle-Jurassic time in the Cox Canyon, Job Peak and White Cloud Canyon areas.

During the Late Oligocene two granitic plutons were emplaced on the east side of the Stillwater Range. Volcanism resumed in the Miocene with the extrusion of Miocene rhyolite flows, tuffs and welded tuffs.

A Pliocene basalt unit was the last volcanic formation deposited in the area. Thick accumulations of Pliocene sediments derived from newly formed tectonic highlands were deposited in the adjacent valleys.

Basin and Range type normal faulting started during the Late Tertiary continues to the present, and is responsible for much of the present day topography. Seismic activity, associated with faults on the eastern flank of the range, caused earthquakes in 1954 (Slemmons, 1957).

III. ENERGY AND MINERAL RESOURCES

A. METALLIC MINERAL RESOURCES

1. Known Mineral Deposits

Eight metallic mining districts are located in the Stillwater Range GRA and are shown on the Metallics Land Classification and Mineral Occurrence Map. Copper Kettle, White Cloud, Shady Run, and Cox Canyon districts are on the western side of the range and the Corral Canyon, Dixie Valley and I.X.L., and Mountain Wells districts are on the eastern side of the range.

The Copper Kettle district is in Copper Kettle Canyon in the northern portion of the GRA. The district was discovered in 1908 with some production of copper ore in 1917 and 1929 (Vanderburg, 1940). Ore occurs near a diorite porphyry-limestone contact several miles up the canyon. Iron is found in the form of magnetite along shears in a jabbroic complex to the west inside the WSA.

The White Cloud district, also known as the Coppereid district, is in White Cloud Canyon inside WSA NV 030-104 about six miles south of the Copper Kettle district. The district was developed during the 1870s, and a copper smelter at the mouth of the canyon operated during the 1890s. Several carloads of hand-sorted copper ore was shipped from the surface workings and averaged about 26% copper, $1 in gold, and 1 ounce of silver to each percent of copper (Vanderburg, 1940). From 1948 through 1952 the U. S. Bureau of Mines Minerals Yearbooks reported a small yearly production of 202 tons of ore valued at $9,936. Workings in the district include the main adit, 3,050 feet long, several shorter adits, numerous shallow shafts and pits. The ore deposits consisted of bodies of secondary copper minerals in metamorphosed limestone in a large contact metamorphic aureole surrounding a granite pluton (Ransome, 1909).

The Shady Run district includes the area from Mill Canyon on the south to Fondaway Canyon on the north on the west side of the range. Although discovered in the late 1800s, there is no recorded production for this area until the Quick-Tung property in Fondaway Canyon began producing tungsten in 1958 (Davis and Ashizawa, 1959). There is current gold production on a small scale at the Fisk-Robertson(?) property in Fondaway Canyon (Bennett, 1983) but nothing additional is known concerning this property. In addition small quartz veins bearing some gold, but no silver, have been prospected by shallow pits and adits. The tungsten occurs as scheelite pods and crystals in a coarsely crystalline marble. In another nearby small deposit the tungsten occurs disseminated in white marble

cut by quartz veins containing cinnabar and a small amount of native mercury (Willden and Speed, 1974). The principal deposit on the north side of the canyon is developed by a shaft and stope approximately 80 feet deep and has produced about 10,000 units of WO_3. Lime-silicate minerals are lacking and no intrusive bodies have been found close to the deposits. These facts combined with the reported presence of quartz and sulphides suggest a hydrothermal origin (Willden and Speed, 1974).

An iron deposit at the range front north of Fondaway Canyon has produced a few truckloads of ore. The deposit reportedly occurs in Jurassic quartzite near its contact with a granitic pluton.

Very minor gold production has come from the Cox Canyon district along the southwest border of WSA 030-104 which is noted for its fluorite mineralization. Located west of the I.X.L. district, the gold produced from Cox Canyon is reported to have been obtained by mortaring and hand panning quartz from veins that crosscut the slate country rock. It is also reported that at least two major mining companies are presently interested in this district (Bennett, 1983).

The Corral Canyon district on the very northern border of the GRA, north of WSA NV 030-104, has produced a very limited amount of gold from lenticular quartz bodies in the gabbroic complex located here. There is also reported to be titanium present at this location as well.

The Dixie Valley district along the northeast edge of WSA NV 030-104 has produced about $300,000 in gold from the Dixie Comstock mine which was active from 1934 to 1942 (Willden and Speed, 1974). The property is developed by an inclined shaft, levels off the shaft and stopes. The ore body is a quartz vein in altered rhyolite that occurs as a plug intruding a large mass of gabbro (Page, 1965).

The I.X.L. district midway between the two WSAs, was, discovered in 1878 and, has had a total production of about $20,000 from epithermal quartz and calcite veins in limestone carrying native silver, horn silver, gold, and lead, and base and precious metals in a contact zone between limestone and granite (Vanderburg, 1940).

The Mountain Wells (La Plata) district is in the southeastern Stillwaters just outside the southern boundary of WSA NV 030-127. No production was recorded but exploration took place along quartz veins in phyllite and slate near contacts with granodiorite plutons.

2. Known Prospects, Mineral Occurrences and Mineralized Areas

Numerous prospects for various commodities are often located in and near known mining districts in the Stillwater Range GRA. Near the mouth of Copper Kettle Canyon in the northwest corner of the GRA, an area has been prospected for iron ore and some magnetite-hematite ore has been developed. Veins of magnetite-calcite-chlorite occur in breccias and shears in albitite, diorite and anorthositic gabbro of the Humboldt gabbroic complex and in altered volcanics.

On the ridge south of White Cloud Canyon in WSA NV 030-104 is the Coppereid breccia pipe complex currently being explored for iron, fluorite, and precious metals by Fischer-Watt Mining Company. The interconnected breccia pipes occur along a N 70° W trend, and contain mineralized breccias and massive hematite (Fischer-Watt Mining Company Monthly Report, May 5, 1982)

In the LaPlata Canyon-Elevenmile Canyon area near the southern border of WSA NV 030-127, Cache Creek Mining Company is evaluating a molybdenite prospect. Cache Creek is exploring for a deep molybdenite target beneath a banded calc-silicate hornfels that locally contains very fine-grained ore grade disseminated molybdenite. According to Mr. Rob Foster (1983), general partner of Cache Creek Mining Company, the property has the parameters to be a good exploration target, and subsequent to detailed mapping some deep holes will be drilled. Other small prospects in the area are located on silver-bearing veins peripheral to the molybdenite system.

The Creole mine is located about three miles north of Job Peak just inside the north boundary of WSA NV 030-127. Its location is shown on topographic and BLM maps, but no description was found in the literature and its purpose in being is unknown.

There are also numerous other prospects shown on topographic maps inside both WSAs. They have been marked on the Copperied Nevada BLM Wilderness Inventory Map that is included as a part of the GRA File.

3. Mining Claims

There are many patented claims in the GRA. There is nearly a square mile of patented ground in the White Cloud district, all of which is inside the west boundary of WSA NV 030-401. There are also patented claims southwest of the Dixie Valley district which are within the same WSA. Other patented claims are found in the I.X.L. district, but they are outside both WSA boundaries.

Most unpatented claims in the study area are clustered around the existing mining districts that have been previously discussed, except for several large claim blocks and several scattered claim groups.

The Cache Creek Mining Company has at least 100 claims in the Elevenmile Canyon area covering a large molybdenum target.

Anaconda Mining Company has a large block of claims north of Table Mountain in Poco Canyon with some of the claims lying inside the northern boundary of WSA NV 030-127. The claims were staked on precious metals-bearing veins with wide zones of epithermal alteration. Sulphide mineralization associated with intrusives also reportedly occurs in this area. This claim group has recently been leased to another party (conversation with James Delong, Senior Geologist for Anaconda).

Occidental Minerals has claims on several sections of land on the west flank of the Stillwater Range in the Shanghai Canyon area many of which are inside WSA NV 030-104. It is unknown at this time what commodity is being explored for in this area.

The Fisk-Robertson(?) gold property in Fondaway Canyon consists of a claim group.

4. Mineral Deposit Types

Mineral deposit types found within the Stillwater GRA include copper bearing contact metamorphic deposits, mineralized explosion breccias, epithermal base and precious metal-bearing quartz veins, molybdenite porphyry, hydrothermal tungsten and tungsten-mercury deposits.

Minor copper production has come from both the Copper Kettle and White Cloud districts on the west flank of the range. Schrader (1947) reported that copper ore in the Copper Kettle district occurs near a limestone-diorite porphyry contact. No specific geologic data concerning this district is readily available. Several car loads of hand-sorted copper ore was produced from pods of secondary copper minerals in metamorphosed limestone in a large contact metamorphic aureole surrounding a granite pluton (Willden and Speed, 1974).

The mineralized breccia pipe complex currently being explored by Fischer-Watt Mining Company for fluorite, iron and precious metals is located on the ridge south of White Cloud Canyon. Zoning of mineralization is suggested by fluorite rich breccias in the northwest, hematite rich breccias in the center and gold- and silver-bearing breccias in the southeast. It appears that there is a

line bearing N 70° W of interconnected explosion breccia pipes that have been zonally mineralized (L. Buchanan written communication, January, 1983 in GRA File).

Narrow quartz veins in the Shady Run district have been prospected for gold, but were probably not very profitable judging by the small size of the prospects. The veins are generally from a few inches to several feet in width, and contain weakly iron-stained quartz, some calcite and a trace of gold. Gold has been panned from gravels in Fondaway Canyon and several samples from this area contained from 0.7 to 7% arsenic. The Dixie Comstock mine on the east flank of the range produced about $300,000 in gold from an epithermal quartz vein in altered rhyolite that occurs as a plug intruding a large gabbro body of Jurassic age (Page, 1965). Production figures indicate that the tenor of the ore was about $16.00/ton ($32/oz Au) with a 2/3 gold-to-silver ratio. Large quantities of hot water were encountered less than 75 feet from the surface which hindered mining.

The Fisk-Robertson(?) property in Fondaway Canyon has reportedly had gold production for the last two years, but the nature of the mineralization here is unknown to these authors.

The Anaconda claim block northwest of Job Peak was staked on precious metals-bearing veins with wide zones of epithermal alteration. Sulphide mineralization associated with intrusives also reportedly occurs in this area (conversation of James DeLong, Senior Geologist, Anaconda Mining Company).

Small epithermal gold-bearing quartz veins that cut the slate country rock in the Cox Canyon District have had a very minor production (Vanderburg, 1940). Quartz and calcite veins in the I.X.L. district east of Cox Canyon have had modest production of precious and base metals.

The hydrothermal(?) Quick-Tung tungsten mine in the Shady Run district and the Quick-Tung quicksilver mine, about one-quarter mile to the west, have produced 10,000 units of WO_3 and a small amount of mercury. The tungsten mine developed scheelite pods and crystals in coarsely crystalline marble. The upper part of this deposit reportedly has quartz, stibnite and valentinite associated with the scheelite. The smaller tungsten mercury deposit one-quarter mile to the west contains disseminated tungsten in marble that is cut by cinnabar-bearing quartz veins. Because of the absence of tactite mineralization and the reported presence of sulfides and quartz (Lawrence, 1963) a hydrothermal origin, as differentiated from pyrometasomatic, for these deposits seems plausible.

On the southern border of WSA NV 030-127 a deep molybdenite target is currently being explored by Cache Creek Mining Company. According to Mr. R. Foster, general partner for Cache Creek, a large manganese, fluorite, tin, silver and tungsten halo surrounds a banded calc-silicate hornfels that locally contains up to 1% disseminated molybdenite. Although previous drilling by Freeport did not hit favorable intercepts, it is postulated by Foster that the better values are at a greater depth. The mineralization is associated with a large intrusive complex and some stockwork veining is present.

An explosion breccia pipe complex in the White Cloud district reportedly has zonational mineralization ranging from fluorite at one end, hematite in the middle and precious metals at the other end. The interconnected breccia pipes occur along a N 70° W trend. Fluorite and precious metal mineralization occurs in the breccias. At least 31,000 tons of hematite at an estimated grade of 90% would be amenable to open-pit mining (Fischer-Watt Mining Company Monthly Reports for May and June, 1982).

5. Mineral Economics

Excluding the Dixie Comstock mine on the northeast flank of the range in the Dixie Valley district, epithermal veins in the GRA have not been highly productive, and it is doubtful that major mining companies would explore for similar type targets in the Stillwater Range. It is possible that additional reserves exist in the Dixie Comstock mine, although high underground mining cost may preclude the interest of major mining companies here also. Epithermal vein deposits of this type may, however, be of interest to small companies or the independent miner.

Although none of the mining districts have produced large quantities of metallic minerals, favorable host rocks, structure, and Mesozoic and Tertiary intrusives are abundant in the study area, offering potential for large disseminated gold deposits.

The potential for a large molybdenite deposit exists in the southern end of the GRA. Low metal prices at this time would adversely affect the economic feasibility of getting a mine into production until molybdenum prices rebound.

According to Mr. Buchanan of Fischer-Watt Mining Company, the Coppereid breccia pipe complex has sufficient open pit tonnages of specular grade hematite to possibly justify a small mine. However, access will be a major problem as the existing road has long segments over 30% grade. It is unknown at this time if the fluorite and precious metals deposits have sufficient mineralization to be profitably

developed.

It is evident from the large number of unpatented claims and major mining companies interested in the Stillwater Range, that the area has a high exploration potential for various types of mineral commodities.

Comments on the draft reports of this study by the Nevada Mining Association state the Stillwater Range GRA has a very high mineral potential with favorable host rocks for base and precious metals and the area has heavy exploration activity.

The largest use for copper is in electrical equipment and supplies and in smaller gauge wire where its electrical conductivity is essential. It is also used in large quantities in applications where its corrosion resistance is important -- in housing, brass and bronze, sea-water corrosion resistant alloys and others. It is used also in ammunition, many chemicals, and in applications where its conductivity of heat is important. World production is about 7.5 million metric tons annually, of which the United States produces about 1.5 million tons, nearly sufficient to satisfy domestic demand. Copper is a strategic metal. There are large reserves of copper ore in the world, and the United States has greater reserves and greater resources than any other country. United States demand is expected to nearly double by the year 2000, but reserves are thought to be sufficient to meet the demand. However, environmental problems of smelting copper may hinder production, and in times of low prices foreign producers tend to maintain full production for political reasons, while domestic producers tend to restrict production for economic reasons. These pressures on the copper industry weaken its competitive capability on the work market. At the end of 1982 the price of copper was 73 cents per pound.

More than half of all tungsten used is in the form of tungsten carbide, a hard and durable material used in cutting tools, wear-resistant surfaces and hard-faced welding rods. Lesser quantities are used in alloy steels, in light bulb filaments, and in chemicals. World production of tungsten is nearly 100 million pounds annually, of which the United States produces somewhat more than six million pounds, while using more than 23 million pounds. The shortfall is imported from Canada, Bolivia, Thailand and Mainland China, as well as other countries. Tungsten is a strategic and critical metal. United States demand is projected to about double by the year 2000, and most of the additional supply will probably be imported, because large reserves are in countries in which profitability is not a factor -- they need foreign exchange, and therefore sell at a price that few domestic mines can match. Tungsten prices F.O.B. mine are quoted

for "short ton units", which are the equivalent of 20 pounds of contained tungsten. At the end of 1982 the price of tungsten was about $80 per short ton unit.

The principal use for mercury is in the manufacture of alkalies and chlorine, in which the mercury does not become a part of the final product, but is used as an electrical conductor and a sealant. Thus it theoretically is not consumed, but in fact, some is lost during the process so some renewal is constantly required. The start-up of a single alkali- or chlorine-producing plant calls for very large quantities of mercury for the initial installation. Electrical applications, including mercury batteries, lamps, rectifiers and switches account for nearly one-third of consumption; and paints, agricultural chemicals and dental amalgam require substantial quantities. Mercury is measured in units of flasks, one flask being 76 pounds of mercury. The United States consumes nearly 50,000 flasks per year and produces about one-half this much -- most of it from the McDermitt mine in northwestern Nevada. The principal world producers are Italy, U.S.S.R., Spain, Algeria and China. Italy and Spain are considered to control the world market because their deposits are large and rich. Numerous mines in the western United States, most of them small, have produced mercury in the past but in general they cannot compete on the world market today. Mercury is listed as a strategic metal. United States demand for mercury is forecast to remain at about its present level to the year 2000 (principally because toxic effects of the metal discourage uses in any but the most essential applications), while domestic production is expected to drop to essentially zero when the McDermitt deposit is exhausted. The price for mercury at the end of 1982 was $360 per flask.

The major use of gold is for storing wealth. It is no longer used for coinage because of monetary problems, but many gold "coins" are struck each year for sale simply as known quantities of gold that the buyer can keep or dispose of relatively easily. The greatest other use of gold is in jewelry, another form of stored wealth. In recent years industrial applications have become increasingly important, especially as a conductor in electronic instrumentation. In the United States and some other countries gold is measured in troy ounces that weigh 31.1 grams -- twelve of which make one troy pound. Annual world production is about 40 million ounces per year, of which the United States produces somewhat more than one million ounces, less than one-fourth of its consumption, while the Republic of South Africa is by far the largest producer at more than 20 million ounces per year. World production is expected to increase through the 1980s. For many years the price was fixed by the United States at $35 per ounce, but after deregulation the price rose to a high of more than $800 per ounce and then dropped to the

neighborhood of $400 per ounce. At the end of 1982 the price was $460.50 per ounce.

B. NONMETALLIC MINERAL RESOURCES

1. Known Mineral Deposits

The Revenue fluorspar mine is located inside WSA NV 030-104 in Sec. 9, T 21 N, R 33 E on the upper north side of Cox Canyon in the Cox Canyon district. Production of fluorite between 1952-1957 and in 1942 amounted to about 1,900 tons. The mine is located in the vicinity of the Cox Canyon thrust zone where the slate and limestone country rocks have been tightly folded. Much of the fluorspar occurs along a north-northeasterly trending fault zone. A 430-foot adit and an inclined shaft have developed this vein and the northern part has been stoped for over 100 feet (Papke, 1979). This is the only non-metallic mine located within the Stillwater Range GRA.

2. Known Prospects, Mineral Occurrences and Mineralized Areas

Fluorite is the only known nonmetallic mineral described in available research material. It occurs as an associated mineral at several mines in the White Cloud and Shady Run districts.

According to Fisher-Watt Mining Company, fluorite occurs as gangue material in the hematite bearing portion of an explosion breccia pipe located in the White Cloud Mining district in WSA NV 030-104.

In another nearby breccia pipe some areas bearing fine grained fluorite are up to 40 feet wide and contain about 40% fluorite, but most average about 5-15% fluorite (Fisher-Watt Mining Company, Monthly Report, June 6, 1982).

The Quick-Tung mine, an active tungsten mine in the Shady Run district, has fluorite associated with magnetite, molybdo-scheelite, calcite, quartz and garnet in contact metamorphic deposits (Papke, 1979).

The limestones in the GRA have potential for use in cement or lime manufacture and it could be said that all other rock types have some potential for utilization as nonmetallics depending on their individual physical or chemical properties.

To the immediate west of the GRA in the Carson Sink there is a large area of the playa which has been leased for sodium. This depositional environment is not found in either WSA in the GRA, however.

3. Mining Claims, Leases and Material Sites

No patented claims or leases covering nonmetallic mineral deposits are known within the GRA.

Unpatented claims near the White Cloud district in Secs. 19 and 20, T 23 N, R 34 E, cover fluorite rich breccias in an explosion breccia pipe currently being evaluated by Fischer-Watt Mining Company.

Unpatented claims in the Shady Run district are most probably located for the metallic mineral potential as fluorite occurs only as gangue material.

Probably many of the unpatented claims in the Cox Canyon district cover the Revenue fluorspar mine and vicinity.

4. Mineral Deposit Types

Fluorspar in the Stillwater Range GRA occurs as replacement bodies in limestone, as irregular veins in limestone and phyllite, and as gangue in base and precious metal-bearing contact deposits.

The alluvium in both WSAs can be utilized for sand and gravel and there are many material sites on both flanks of the range. The only material site known to be inside either WSA though is one in Sec. 28, R 32 E, t 20 N, of WSA NV 030-127.

The Revenue mine, located in the Cox Canyon district, produced about 1,900 tons of fluorspar from replacement bodies in limestone beds interlayered in a sequence of phyllite and slate. These rocks have been folded with axial regions being most completely replaced due to structural preparation by fracturing. In the same area, fluorspar also occurs as irregular veins in limestone and phyllite, with the phyllite commonly silicified adjacent to the veins (Willden and Speed, 1974).

At the Quick-Tung mine in the Shady Run district, fluorite occurs as gangue material with the molybdo-scheelite ore in a contact metamorphic deposit (Lawrence, 1963). In the White Cloud district, fluorite occurs as gangue with specular hematite and minor copper mineralization in an explosion breccia pipe currently being explored by Fisher-Watt Mining Company.

5. Mineral Economics

Production of fluorspar in the Stillwater GRA has been relatively minor. Nineteen hundred tons had been produced and concentrated to acid-grade concentrate (97% CaF and <1.0-1.5% SiO_2) in the Kaiser Mill at Fallon from a vein like deposit in Cox Canyon developed by the Revenue mine in 1942 and 1952-1957. Five samples taken in 1943 in the main adit and shaft by U. S. Bureau of Mines personnel contained 58-89% CaF indicating that low grade ore still exists in the mine; however, it is not known what reserves remain in the deposit (Willden and Speed, 1974).

The fluorite bearing breccia pipe currently being explored by Fischer-Watt Mining Company may have significant size potential to be mined economically. Specific tonnage and grade data are not available at this time.

By far the greatest use of fluorite (or fluorspar) is in the production of hydrofluoric acid, which has many industrial applications. Other uses are in steelmaking, welding rods, refining of a number of metals, and in the production of certain glasses. World production of fluorine, the principal component of fluorite, is about 2.5 million tons annually, of which the United States produces less than 100 thousand tons, nearly half of this being in the form of fluorosilicic acid that is a byproduct of phosphate production. United States consumption is about 700 thousand tons annually, with more than half of the shortfall imported from Mexico, and the remainder mostly from South Africa, Spain and Italy. Fluorite is a strategic and critical mineral. United States demand for fluorite is expected to increase by about 50% by the year 2000, and probably all of the increase will be imported. In 1980 the price of fluorite was about $65 to $85 per ton, depending upon the quality.

The most common use of sand and gravel is as "aggregate" -- as part of a mixture with cement to form concrete. The second largest use is as road base or fill. About 97 percent of all sand and gravel used in the United States is in these applications in the construction industry. The remaining three percent is used for glassmaking, foundry sands, abrasives, filters and similar applications. The United States uses nearly one billion tons of sand and gravel annually, all of it produced domestically except for a very small tonnage of sand that is imported for highly specialized uses. Since construction is by far the greatest user of sand and gravel, the largest production is near sites of intensive construction, usually metropolitan areas. Since sand and gravel are extremely common nearly everywhere, the price is generally very low and mines are very close to the point of consumption -- within a few miles as a rule. However, for some applications such as high-quality

concrete there are quite high specifications for sand and gravel, and acceptable material must be hauled twenty miles and more. Demand for sand and gravel fluctuates with activity in the construction industry, and is relatively low during the recession of the early 1980s. Demand is expected to increase by about one-third by the year 2000. In the early 1980s the price of sand and gravel F.O.B. plant averaged about $2.50 per ton but varied widely depending upon quality and to some extent upon location.

C. ENERGY RESOURCES

Uranium and Thorium Resources

1. Known Mineral Deposits

There are no known uranium or thorium deposits in the WSAs or GRA.

2. Known Prospects, Mineral Occurrences and Mineralized Areas

There is one uranium occurrence in the GRA near the northern edge of WSA NV 030-104 (see Uranium Land Classification and Mineral Occurrence Map) where uranophane and iron and copper oxides occur in a fault zone cutting rhyolitic volcanics at the KD group (116 claims in Sec. 22(?), T 24 N, R 34 E). Just north of the northeast corner of the GRA, uranium is associated with nickel, cobalt and copper minerals in veinlets along a sheared contact between gabbro and albitized Jurassic arenite at the Cottonwood claims (Secs. 27 and 34, T 25 N, R 36 E) (Garside, 1973).

Mobil Oil Corporation located a large claim block in Dixie Valley, east of the Stillwater Range. The claims were drilled to test the uranium potential in this area. Results were quite unfavorable and the claims allowed to lapse (Howell, 1983).

3. Mining Claims

There are numerous unpatented claims in the GRA, but it is unknown if any current claims are for uranium or thorium. Mobil Oil Corporation had uranium claims in Dixie Valley, east of the Stillwater Range, but these have been dropped due to unfavorable results.

4. Mineral Deposit Types

Deposit types cannot be discussed due to the lack of known uranium or thorium deposits in the GRA.

5. Mineral Economics

Uranium and thorium appear to be of little economic value due to the lack of known deposits of these elements in the GRA.

Uranium in its enriched form is used primarily as fuel for nuclear reactors, with lesser amounts being used in the manufacture of atomic weapons and materials which are used for medical radiation treatments. Annual western world production of uranium concentrates totaled approximately 57,000 tons in 1981, and the United States was responsible for about 30 percent of this total, making the United States the largest single producer of uranium (American Bureau of Metal Statistics, 1982). The United States ranks second behind Australia in uranium resources based on a production cost of $25/pound or less. United States uranium demand is growing at a much slower rate than was forecast in the late 1970s, because the number of new reactors scheduled for construction has declined sharply since the accident at the Three Mile Island Nuclear Plant in March, 1979. Current and future supplies were seen to exceed future demand by a significant margin and spot prices of uranium fell from $40/pound to $25/pound from January, 1980 to January, 1981 (Mining Journal, July 24, 1981). At present the outlook for the United States uranium industry is bleak. Low prices and overproduction in the industry have resulted in the closures of numerous uranium mines and mills and reduced production at properties which have remained in operation. The price of uranium at the end of 1982 was $19.75/pound of concentrate.

Thorium is used in the manufcature of incandescent gas mantles, welding rods, refractories, as fuel for nuclear power reactors and as an alloying agent. The principal source of thorium is monazite which is recovered as a by-product ot titanium, zirconium and rare earth recovery from beach sands. Although monazite is produced from Florida beach sands, thorium products are not produced from monazite in the United States. Consequently, thorium products used in the United States come from imports, primarily from France and Canada, and industry and government stocks. Estimated United States consumption of thorium in 1980 was 33 tons, most of which was used in incandescent lamp mantles and refractories (Kirk, 1980b). Use of thorium as nuclear fuel is relatively small at present, because only two commercial thorium-fueled reactors are in operation. Annual United States demand

for thorium is projected at 155 tons by 2000 (Kirk, 1980a). Most of this growth is forecast to occur in nuclear power reactor usage, assuming that six to ten thorium-fueled reactors are on line by that time. The United States and the rest of the world are in a favorable position with regard to adequacy of thorium reserves. The United States has reserves estimated at 218,000 tons of ThO_2 in stream and beach placers, veins and carbonatite deposits (Kirk, 1982); and probably cumulative demand in the United States as of 2000 is estimated at only 1,800 tons (Kirk, 1980b). The price of thorium oxide at the end of 1981 was $16.45 per pound.

Oil and Gas Resources

1. Known Oil and Gas Deposits

There are no known oil and gas deposits in the GRA.

2. Known Prospects, Oil and Gas Occurrences and Petroliferous Areas

There are no known oil and gas seeps, but there were gas shows in the Standard Oil of California Co. Standard-Amoco-Southern Pacific Land Co. No. 1 well (Locality #1 on the Oil and Gas Occurrences and Land Classification Map), drilled one mile outside the GRA boundary. This 1974 well went to 11,000 feet (Garside and others, 1977).

Further south four shallow exploratory wells were drilled: two (#2 and #3) inside the GRA; one (#4) in WSA 030-127; and one (#5) five miles outside the GRA (Lintz, 1957):

Locality Number	Operator/Well TD and Date
#2	Council Oil Co. No. 1 TD 300' 1921
#3	Fallon Nevada Oil Co. No. 1 TD 1250' 1921
#4	Fallon Pioneer Oil Co. No. 1 TD 1540' 1929?
#5	Cal Neva Oil Co. May Bros. No. 1 TD 1560' 1922

None of these four wells had shows of oil or gas (Nevada

Bureau of Mines and Geology Oil and Gas Files, 1982).

3. Oil and Gas Leases

Oil and gas leases cover nearly all of the GRA underlain by valley alluvium and a portion of the mountains as well.

4. Oil and Gas Deposit Types

Oil deposits that have been found and developed, and those that are being explored for in the Basin and Range to date, have been limited to the Upper Paleozoic section of the miogeosyncline and the Tertiary section of the intermontane basins. The source rocks are assumed to be in Paleozoic horizons, such as the Mississippian Chainman Shale, and perhaps also in the Tertiary section.

5. Oil and Gas Economics

The reservoirs at the Trap Spring and Eagle Springs oil fields in Railroad Valley are the Oligocene Garrett Ranch volcanics or equivalent, which produce from fracture porosity; or the Eocene Sheep Pass Formation, a freshwater limestone. Minor production has been recorded from the Ely(?) Formation of Pennsylvanian age at Eagle Springs. It may be that production also comes from other units in the Tertiary or Paleozoic sections in the Blackburn oil field in Pine Valley or the Currant and Bacon Flat oil fields in Railroad Valley.

Geothermal Resources

1. Known Geothermal Deposits

There are two known geothermal deposits in the GRA. On the Geothermal Occurrence and Land Classification Map these are:

#1 Dixie Comstock mine
Hot water; large volume at less than 75'

#2 Dixie Hot Springs
162°F; numerous springs

(Garside and Schilling, 1979)

2. Known Prospects, Geothermal Occurrences and Thermal Areas

Nearly all of the valley and lower mountain slope areas in

Dixie Valley and the Carson Sink are prospects, in that there are hundreds of temperature gradient holes which have recorded anomalously high temperatures and thermal gradients. Prospects and/or occurrences of record are:

#3 Thermal Power Co., Dixie Federal No. 45-14, TD 9,022' 1979, 385°F (Nevada Bureau of Mines and Geology, 1982)

#4 Several water wells with temperatures of 70° to 75° (Garside and Schilling, 1979)

#5 Rosewood Corporation Pirouette Mountain No. 66-16, Hot water; TD 7397'; 1981 (Nevada Bureau of Mines and Geology, 1982)

#6 Rosewood Corporation, Eleven Mile Canyon Fed. 52-14, TD 8264', 1982, anomalously high temperatures and thermal gradient (Personal Communication, Rosewood Corp., 1982) (Location?)

#7 Rosewood Corporation, Eleven Mile Canyon Fed. 72-23, TD 7459', 1981, anomalously high temperatures and thermal gradient (Personal Communication, Rosewood Corporation, 1982)

#8 Standard Oil of California, Standard-Amoco-Southern Pacific Land Company No. 1, TD 11,000', 1974, 285°F (Nevada Bureau of Mines and Geology Oil and Gas Files, 1982)

#9 U. S. Bureau of Reclamation Heat Flow Hole, TD 500', 77°F (Garside and Schilling, 1979)

#10 Union Oil Co. DeBraga No. 2, TD 6,946', 1979, 335°F (Nevada Bureau of Mines and Geology, 1982)

3. Geothermal Leases

Geothermal leases cover most of Dixie Valley and portions of Carson Sink. Leases would be more extensive in Carson Sink were it not for the no leasing policy in the Stillwater Wildlife Refuge and the U. S. Navy bombing facility.

4. Geothermal Deposit Types

Geothermal resources are hot water and/or steam which occur in subsurface reservoirs or at the surface as springs. The temperature of a resource may be about 70°F (or just above average ambient air temperature) to well above 400°F in the Basin and Range Province.

The reservoirs may be individual faults, intricate fault-fracture systems, or rock units having intergranular permeability -- or a combination of these. Deep-seated normal faults are believed to be the main conduits for the thermal waters rising from thousands of feet below in the earth's crust.

The higher temperature and larger capacity resources in the Basin and Range are generally hydrothermal convective systems. The lower temperature reservoirs may be individual faults bearing thermal water or lower pressured, permeable rock units fed by faults or fault systems. Reservoirs are present from the surface to over 10,000 feet in depth.

5. Geothermal Economics

Geothermal resources are utilized in the form of hot water or steam normally captured by means of drilling wells to a depth of a few feet to over 10,000 feet in depth. The fluid temperature, sustained flow rate and water chemistry characteristics of a geothermal reservoir, as well as the end use, determine the depth to which it will be economically feasible to drill and develop each site.

Higher temperature resources (above 350°F) are currently being used to generate electrical power in Utah and California, and in a number of foreign countries. As fuel costs rise and technology improves, the lower temperature limit for power will decrease appreciably -- especially for remote sites.

All thermal waters can be beneficially used in some way, including fish farming (68°F), warm water for year-round mining in cold climates (86°F), residential space heating (122°F), greenhouses by space heating (176°F), drying of vegetables (212°F), extraction of salts by evaporation and crystallization (266°F), and drying of diatomaceous earth (338°F). These are only a few examples.

Unlike most mineral commodities remoteness of resource location is not a drawback. Domestic and commercial use of natural thermal springs and shallow wells in the Basin and Range province is a historical fact for over 100 years.

Development and maintenance of a resource for beneficial use may mean no dollars or hundreds of millions of dollars, depending on the resource characteristics, the end use and the intensity or level of use.

D. OTHER GEOLOGICAL RESOURCES

There are no other unique or unusual geological resources known to exist in the GRA. Coal is not known in the GRA, and there is no known potential for coal.

E. STRATEGIC AND CRITICAL MINERALS AND METALS

A list of strategic and critical minerals and metals provided by the BLM was used as a guideline for the discussion of strategic and critical materials in this report.

The Stockpile Report to the Congress, October 1981-March 1982, states that the term "strategic and critical materials" refers to materials that would be needed to supply the industrial, military and essential civilian needs of the United States during a national emergency and are not found or produced in the United States in sufficient quantities to meet such need. The report does not define a distinction between strategic and critical minerals.

The critical and strategic minerals that have been produced in notable quantity in the Stillwater Range GRA are 1,900 tons of fluorspar from the Revenue mine and about 10,000 units of WO_3 from the Quick-Tung mine. Minor amounts of copper, mercury and silver, listed on the current stockpile list by the Federal Emergency Management Agency have also been produced from small districts on the western flank of the range. It is doubtful that these small deposits would yield significant additional production.

A potential for additional fluorite production exists at the Coppereid explosion breccia pipe complex located in the White Cloud district. This property is currently being explored and the economic feasibility for developing this deposit is unknown at this time. At the Quick-Tung mine the fluorite occurs only as gangue material, and probably not in sufficient quantities to profitably concentrate.

IV. LAND CLASSIFICATION FOR G-E-M RESOURCES POTENTIAL

The geologic map which best covers this entire GRA is Page's (1965) at a scale of 1:125,000. The detail is relatively good except the original base map used for topography was enlarged from a 1:250,000 scale. Page's map is still not adequate to show much in the way of detailed geology in the vicinity of the eight mining districts in the GRA. The map emphasizes gross lithologies and structures and does not show alteration. The quality and level of confidence in this map, however, is very good. The geologic map used for this GRA report is the 1:250,000 map accompanying Willden and Speed (1970). The data on mineral resources comes from both Page (1965) and Willden and Speed (1970). The information on the mining districts is not overly detailed in nature but is a good summary of what is present. We did get some excellent information from individual sources from the mining industry on specific properties in this GRA. Overall, the quantity of data concerning mineral resources is moderate and the quality and level of confidence in that data is high.

Land classification areas are numbered starting with the number 1 in each category of resources. Metallic mineral land classification areas have the prefix M, e.g., M1-4D. Uranium and thorium areas have the prefix U. Nonmetallic mineral areas have the prefix N. Oil and gas areas have the prefix OG. Geothermal areas have the prefix G. Sodium and potassium areas have the prefix S. The saleable resources are classified under the nonmetallic mineral resource section. Both the Classification Scheme, numbers 1 through 4, and the Level of Confidence Scheme, letters A, B, C, and D, as supplied by the BLM are included as attachments to this report. These schemes were used as strict guidelines in developing the mineral classification areas used in this report.

Land classifications have been made here only for the areas that encompass segments of the WSAs. Where data outside a WSA has been used in establishing a classification area within a WSA, then at least a part of the surrounding area may also be included for clarification. The classified areas are shown on the 1:250,000 mylars or the prints of those that accompany each copy of this report.

In connection with nonmetallic mineral classification, it should be noted that in all instances areas mapped as alluvium are classified as having moderate favorability for sand and gravel, with moderate confidence, since alluvium is by definition sand and gravel. All areas mapped as principally limestone or dolomite have a similar classification since these rocks are usable for cement or lime production. All areas mapped as other rock, if they do not have specific reason for a different classification, are classified as having low favorability, with low confidence, for nonmetallic mineral potential, since any mineral material can at least be used in construction applications.

1. LOCATABLE RESOURCES

a. Metallic Minerals

WSA NV 030-104

M1-4D. This classification area of high favorability with a moderate confidence level includes the White Cloud or Coppereid district. This district has produced copper from deposits in metamorphosed limestone in a contact aureole surrounding a nearby granitic pluton. This district and the classification area are within WSA NV 030-104.

M2-4D. This area of high favorability with a high confidence level is the Shady Run district which has produced tungsten and minor amounts of quicksilver in the past and has a small present gold producer. This area also includes an iron deposit with a small amount of past production from the contact between the granitic pluton to the north and the Jurassic quartzite.

M3-4D. This area of high favorability with a high confidence level is the Cox Canyon district which has produced a minor amount of gold from quartz veins cutting across the slate country rock. This classification area is along the southern boundary of WSA NV 030-104. Its boundaries are tentative and need adjustment in the field to see if the old workings actually fall inside the WSA boundary. The 4D classification is because of the reported gold produced.

M4-4D. This area of high favorability with a high confidence level is the Dixie Valley district which produced gold from a quartz vein in a rhyolitic plug intruded into a large gabbroic body. Part of this classification area extends into WSA NV 030-104.

M5-4D. This classification area of high favorability with a high confidence level is the I.X.L. district on the east side of the Stillwaters, up toward the crest. The boundaries of this classification area are approximate only, and the area is outside both WSAs. There has been a total production of about $20,000 in precious metals(?) from epithermal veins in lime units along a contact with a granitic intrusive.

M6-3C. This classification area is one of moderate favorability for iron with a moderate confidence level. It has been prospected for iron ore, and is similar to the large iron mines just north at Mineral Basin and in Pershing County. The iron occurs as magnetite along breccias and shears in both intrusive rocks of a gabbroic complex and the intruded altered volcanic rocks. This is considered as part of the Copper Kettle district and is

inside the northwest corner of WSA NV 030-104.

M7-3B. This moderate favorability classification area with a low confidence level covers the remaining gabbroic intrusive complexes in the northern Stillwaters and is inside the northeast portion of WSA NV 030-104. Some adjacent mafic Mesozoic volcanic units are also included. These units have potential for iron similar to the iron prospect described in M6-3C. Some of the adjacent rock has been included because it has also been mineralized. On the east side of the range in the Dixie Valley district gold production has occurred in a vein in altered rhyolite which has intruded the gabbroic complex. Also southwest of the Dixie Valley mine are several prospects and a patented claim (Secs. 15, 16, and 21 of T 23 N, R 35 E) in this same gabbroic complex, but the commodity for which they were exploring is uncertain.

M8-3C. This moderately favorable classification area with a moderate confidence level is the contact aureole around the large granitic intrusive between White Cloud Canyon and Fondaway Canyon on the west slope of the Stillwaters. The Shady Run and White Cloud districts are located in this environment, and Fischer-Watt is currently evaluating a breccia pipe complex here containing iron, fluorite and precious metals.

M9-2A. The low potential classification area with a very low confidence level is the interior of the intrusive described above in classification M8-3C. There is no evidence to support mineralization in its interior, but since it is in close proximity to and appears to be responsible for the nearby mineralization, a 2 classification has been given it, but with a confidence level of A.

M10-1A. This area shows no indication of favorability with a very low confidence level and includes the outcrop area of the Jurassic mafic volcanic rocks in the very northeast part of the WSA. These same rocks show mineralization to the west on the west base of the mountains in the Copper Kettle district where they have iron mineralization associated with the gabbros. The 1 classification here is because no mineralization is known here, and that part of the unit which is adjacent to the gabbros has been included in classification M7-3B. There are no claims.

M11-3C. This moderate favorability classification area with a moderate confidence level includes all the Triassic shales, siltstones and other minor sediments, including scattered limestones that remain in WSA NV 030-104. The reasons for the 3C classification include the location of four mining districts in this same host rock and the preponderance of mining claims in this unit. Exploration

activity appears high in this area. On Page's map (1965) there are abundant aphanitic dike-like intrusives cutting this unit and structure appears complex.

M12-3B. This classification area is one of moderate favorability with a low confidence level and includes a large area in the northern half of the WSA which is covered by Tertiary volcanics. These volcanics are post-mineralization age and mask what lies below. The concentration of known mineralization and past production from properties surrounding these volcanics would indicate that similar mineralization beneath these rocks is likely, hence the classification 3B.

M13-3B. This moderate favorability classification area with a low confidence level includes the area covered by alluvium on the western side of the range. The 3B classification is because of the abundant mineralization along the range front and the associated preponderance of mining claims. There is a possibility of similar mineralization of the downthrown (western) portion of the Basin and Range faulting here. Depth to any potential mineralization is unknown, however.

M14-3B. This area of moderate favorability with a low confidence level has the same rationale as that area above under M13-3B. It includes the area of alluvium on the eastern side of the range adjacent to the Dixie Valley district.

M15-3A. This classification area of moderate favorability with a very low confidence level includes all the area covered by alluvium on the eastern side of the range south of the Dixie Valley district. The reason for the 3 classification is because the adjacent bedrock is considered to have a moderate potential, and therefore the same bedrock underlying the alluvium would also have a similar potential. The confidence level is A, however because there is no evidence to verify this.

WSA NV 030-127

M16-3C. This classification area of moderate favorability with a moderate confidence level incorporates the Mountain Wells district at the very southern end of the GRA just outside the WSA border. No production has been reported, but minor mineralization is found along quartz veins in the Mesozoic rocks which have been intruded by granodiorite plutons. This area is also covered by unpatented claims and is the area where Cache Creek Mining is exploring a potential buried molybdenum deposit.

M17-2A. This classification area of low favorability with a very low confidence level includes the outcrop area of the large Tertiary granitic intrusive in the northeastern portion of the WSA. There is no evidence of mineralization in these rocks, but their contact with the older Mesozoic sediments has created mineralization in favorable host rocks in the I.X.L. district along its northern border outside the WSA. There is also what is called the Creole mine in this area and a few other prospects the background on which we are lacking. The granitic intrusive actually consists of many separate phases and is intrusive into the surrounding older Tertiary volcanic rocks. The 2 (low) classification is because the intrusive is known to be associated with mineralization in the I.X.L. district, and elsewhere in the Stillwater Range similar intrusives likewise are associated with contact mineralization.

M18-3B. This classification covers the vast majority of the WSA, and includes all the outcrop area of the Tertiary volcanic rocks. The moderate favorability with low confidence level is for the following reasons:

1. These volcanics are younger than the known mineralization to the north in the Stillwaters. Therefore the nature of the underlying mineral potential should be based on exposures where these volcanics are eroded away.

2. Mineralization is found in the underlying Mesozoics to both the north and south.

3. The presence of intrusive granitic rocks which are known to be associated with mineralization to the north in the I.X.L. district is significant. At depth where this intrusive is in contact with the underlying Mesozoic rocks there may be some depositionally favorable horizons that have been mineralized.

4. There are abundant mining claims in this classification area. Anaconda alone has approximately 250 claims in the volcanics of this classification area, the majority of which are within the WSA. The claims were staked on precious metal-bearing veins with wide zones of epithermal alteration. Sulfide mineralization associated with intrusives also reportedly occurs in this area (Delong, 1983).

The B confidence level is because the potential mineralization is based on indirect evidence from outside the WSA and from claims.

M19-3A. This classification area of moderate favorability with a low confidence level covers the alluvium on the east side of the range. The rationale here is the same as for classification area M15-3A to the north.

M20-3A. This classification area is the same as above for M19-3A except this covers the area of alluvium on the west side of the range. Here again, the rationale for the classification is the same as for M15-3A. This area does not have a higher level of confidence such as the alluvial area to the north (M13-3B) because there are not abundant claims and prospects adjacent to them.

b. Uranium and Thorium

WSAs NV 030-104 and WSA NV 030-127

U1-2B. This land classification covers most of the WSA NV 030-104 and WSA NV 030-127 and part of the southwestern, central and northeastern portions of the GRA. The areas are covered by Triassic sediments, Jurassic mafic volcanics, gabbro and arenite, Cretaceous-Tertiary granite to granodiorite and Tertiary volcanics. The area has low favorability with a low confidence level for fracture-filled and intrusive contact uranium deposits. Tertiary rhyolite volcanics and Cretaceous-Tertiary granitic intrusive rocks are possible sources of uranium. Uranium from these rocks could be leached by ground and meteoric water and reprecipitated in fractures within the source rocks or other rocks nearby. Uranium may also have been introduced into wall rocks during emplacement of the granitic intrusives. Uranium has been noted in fractured rhyolite at the north end of the WSA (KD claims), indicating that the area may have some potential for this type of deposit.

The area has low favorability with a very low confidence level for thorium deposits associated with pegmatites which may occur with the granitic intrusives.

U2-2B. This land classification covers the eastern and western margins of WSA NV 030-104, WSA NV 030-127, and the GRA. The areas are covered by Tertiary sediments and Quaternary alluvium, and have low favorability with a low confidence level for epigenetic sandstone uranium deposits. Tertiary rhyolitic volcanics and granitic intrusives are possible uranium source rocks in the area. Leaching of uranium from these rocks by ground water and deposition of the uranium in reduced areas in adjacent alluvium can lead to the formation of sandstone type deposits.

The area has low favorability with a very low confidence

level for thorium in placer deposits in the alluvium. If pegmatites are associated with the granitic intrusives they may be a source for thorium minerals such as monazite which can be concentrated in alluvial material.

c. Nonmetallic Minerals

WSA NV 030-104

N1-4D. This area of high favorability with a high confidence level delineates the Revenue fluorspar mine in the Cox Canyon district which produced approximately 1,900 tons of ore between 1942 and 1957 from a vein in the Mesozoic sediments.

N2-3C. This classification area of moderate favorability with a moderate confidence level includes the contact aureole around the granitic intrusive in the western portion of the WSA including the White Cloud and Shady Run mining districts where fluorite is associated with the other mineralization. No production of fluorite has been reported however, Fischer-Watt Mining Company is exploring a breccia pipe in this classification area between the two districts and has reported mineralization runs as much as 40% fluorite (Buchanan, 1982).

N3-2B. This classification of low favorability with a low confidence level includes the vast majority of the WSA, in that it encompasses all the remaining bedrock exposed in the WSA. These rocks consist of Mesozoic sediments which are mainly shales and siltstones, volcanic rocks ranging from basalts to rhyolites, granitic intrusives and gabbroic complexes. Most any material can find a use in the nonmetallic field for general purposes such as construction materials or if a particular physical or chemical property is found to satisfy a need, hence the classification 2B.

N4-3C. This classification area of moderate favorability with a moderate confidence level includes all the alluvial materials in the WSA as this material could probably be utilized for sand and gravel for nearby construction needs.

WSA NV 030-127

N3-2B. This classification covers all the bedrock exposed in the WSA. The rationale is as stated above for the previous WSA.

N4-3C. This classification is for all the alluvium exposures in the WSA and the rationale is as stated above for the previous WSA.

2. LEASABLE RESOURCES

a. Oil and Gas

WSAs NV 030-104 and NV 030-127

OG1-3A. These WSAs are outside the petroliferous miogeosyncline province. Even so major energy companies have been leasing and exploring for petroleum in this part of the Basin and Range for years. The Standard-Amoco-Southern Pacific Land Co. No. 1 encountered gas shows just outside the GRA. The lands under this classification are contiguous with or environmentally similar to the section drilled in that well.

OG2-1D. This classification includes the complex Stillwater Mountains horst block. There are a multitude of Jurassic metasediments and intrusives, Cretaceous granitic rocks, and Tertiary volcanics and intrusives. There are no source rocks in the section, nor is the structural or stratigraphic environment conductive to hydrocarbon accumulation.

b. Geothermal

WSAs NV 030-104 and NV 030-127

G1-4D. This classification includes the known deposits, Dixie Comstock mine and Dixie Hot Springs, both of which are viable direct use resources. The area incorporates the mountain range faults which act as conduits for the thermal waters.

G2-4C. This classification covers the range front fault areas, which are known to act as hosts for rising thermal waters in G1 and the thermal prospects and occurrences in Dixie Valley and Carson Sink. Numerous temperature gradient holes, drilled over a broad area, are known to show anomalously high temperatures and thermal gradients.

G3-3B. This classification covers the main mountain block of the Stillwaters. Exploration and some leasing has included these areas as parts of the major Dixie Valley and Carson Sink geothermal plays. An important prospect of Amax is present on the east side of Dixie Valley in the New Pass Range, just outside the Clan Alpine GRA. Structural features of that area, and the Dixie Valley prospects and deposits, indicates the Stillwater Mountain horst is also prospective.

c. Sodium and Potassium

WSAs NV 030-104 and NV 030-127

S1-1D. This classification applies to both WSAs. There is no indication of favorability for the accumulation of resources of sodium and potassium in the WSAs. To the west of the Stillwaters and the GRA in the Carson Sink there is a large area covering most of a township (see Sodium Lease Map) that has sodium leases. This depositional environment is not found, however, in either of the WSAs.

3. SALEABLE RESOURCES

Saleable resources, sand and gravel, have been discussed above under nonmetallics and include classification area N4-3C.

V. RECOMMENDATIONS FOR ADDITIONAL WORK

The Stillwater Range is a geologically and structurally complex area that has abundant mineralization with a lot of past and current activity. The entire area is believed to have moderate to high potential for metallic mineral resources. This study is not an in-depth evaluation of this area, but an in-depth evaluation is necessary. Further recommendations to help in the evaluation of the mineral potential of this area include:

1. Detailed geological mapping of the entire area at a scale of perhaps 1:62,500 with emphasis on the mining districts to determine potential pathfinders to mineralization, including alteration, structure, vein extensions, etc.

2. Further discussion with all mining claimants in the area (Our initial inquiries have produced good information but there are many more claimants out there who could add further input.).

3. All mining claims in the WSAs should be looked at in detail to determine their mineral character or potential.

4. It should be emphasized that detailed information concerning mineralization on the peripheries of both WSAs is important in that this type of information can have a direct influence on the evaluation of mineral potential within the WSAs.

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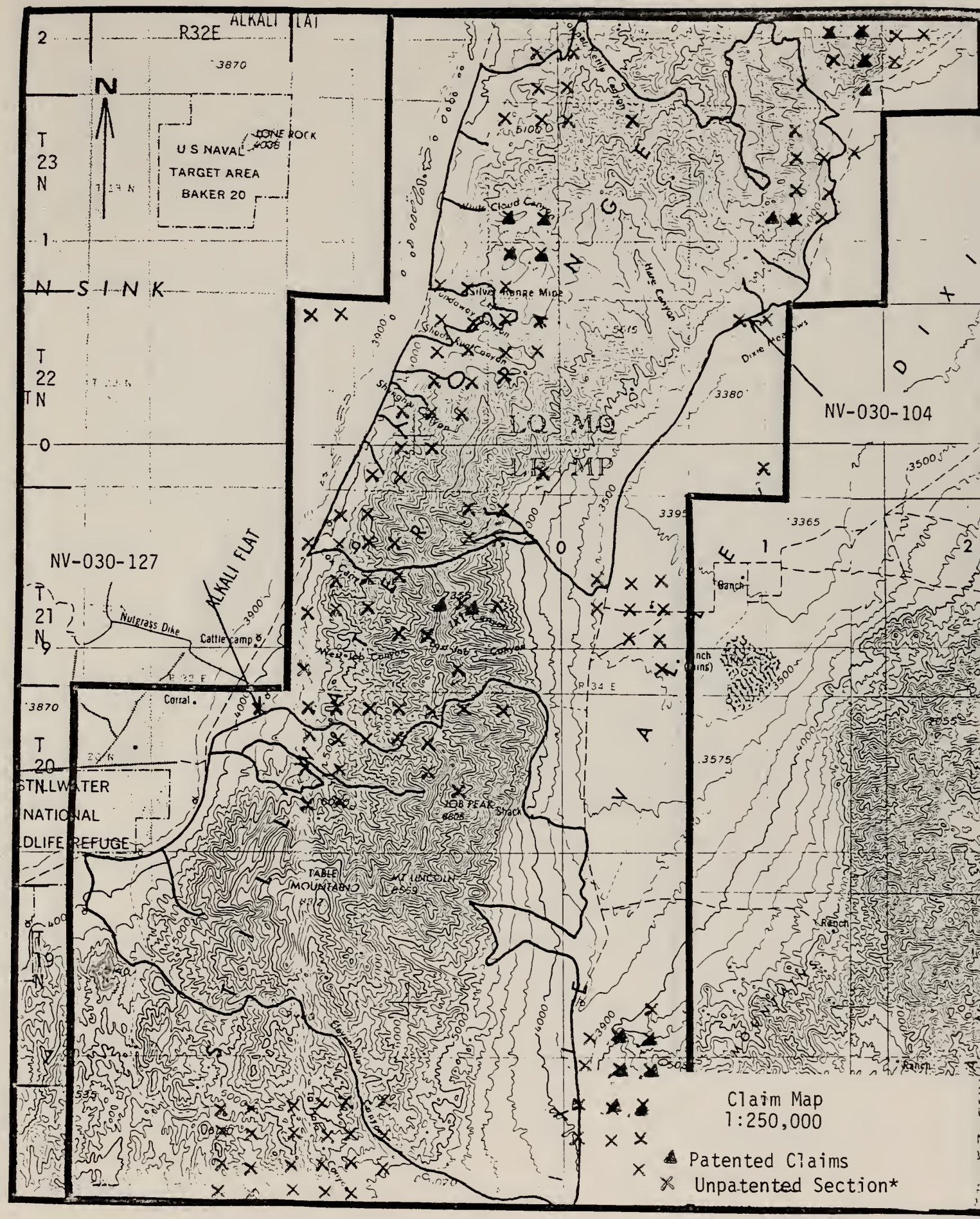

*X denotes one or more claims per section

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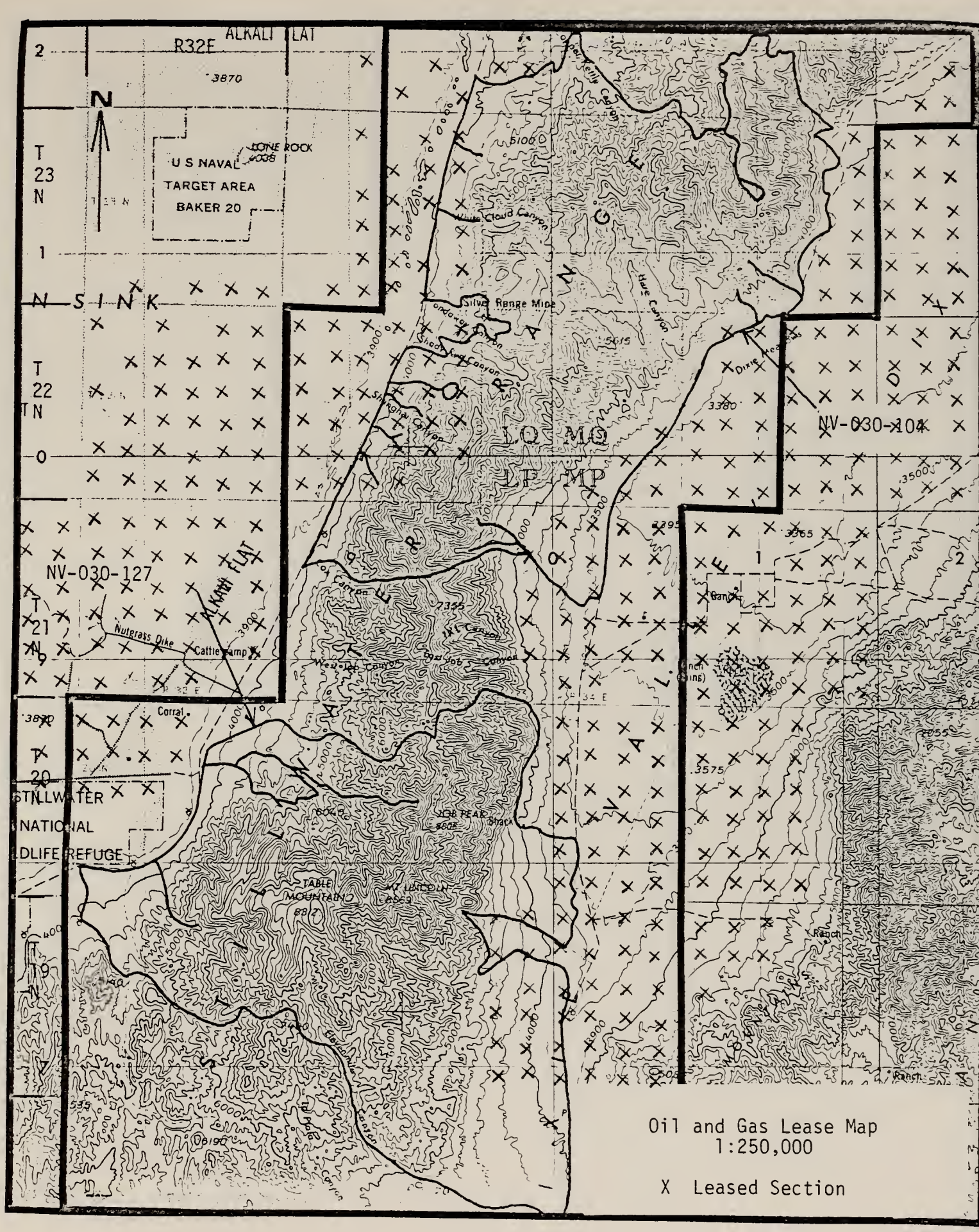

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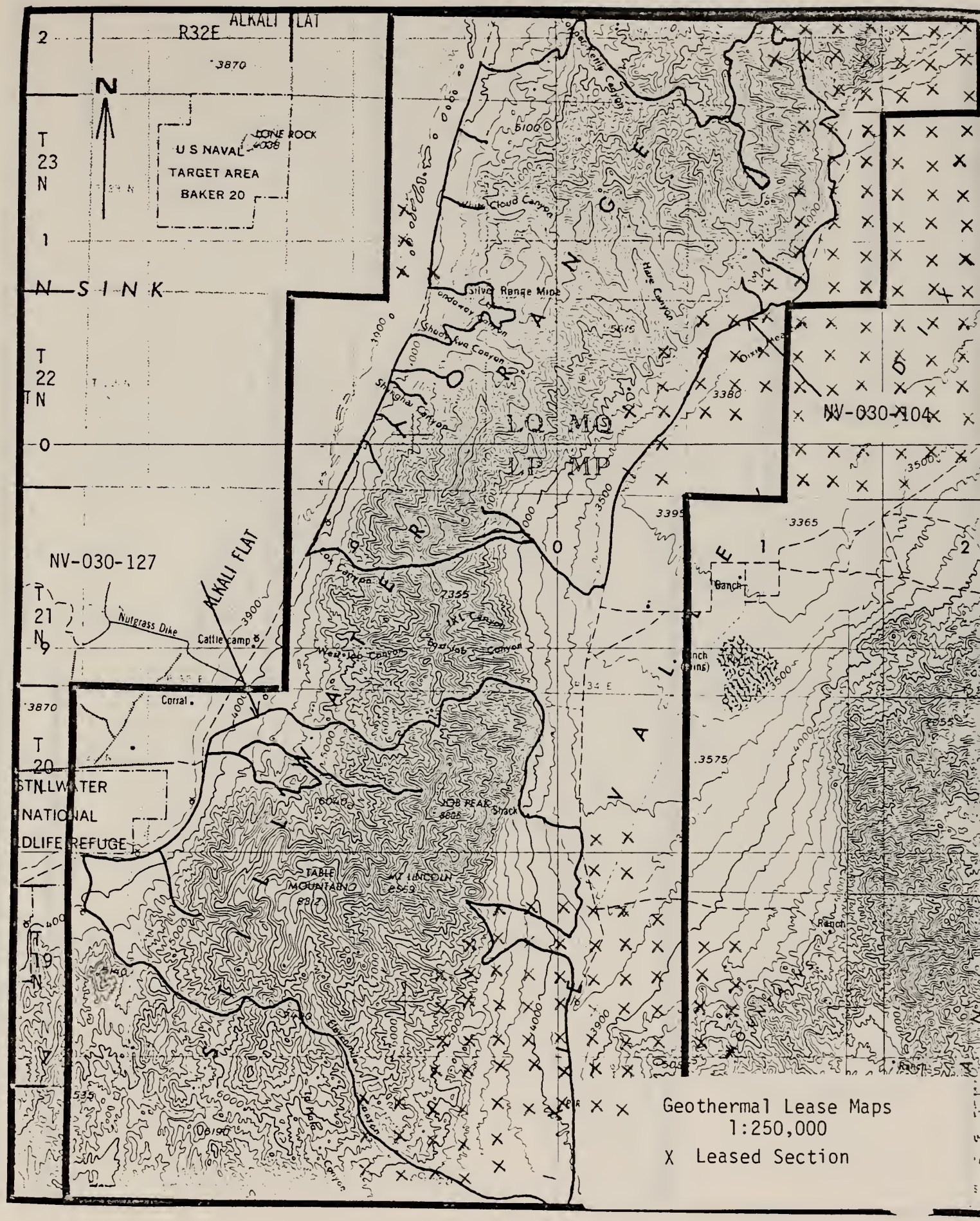

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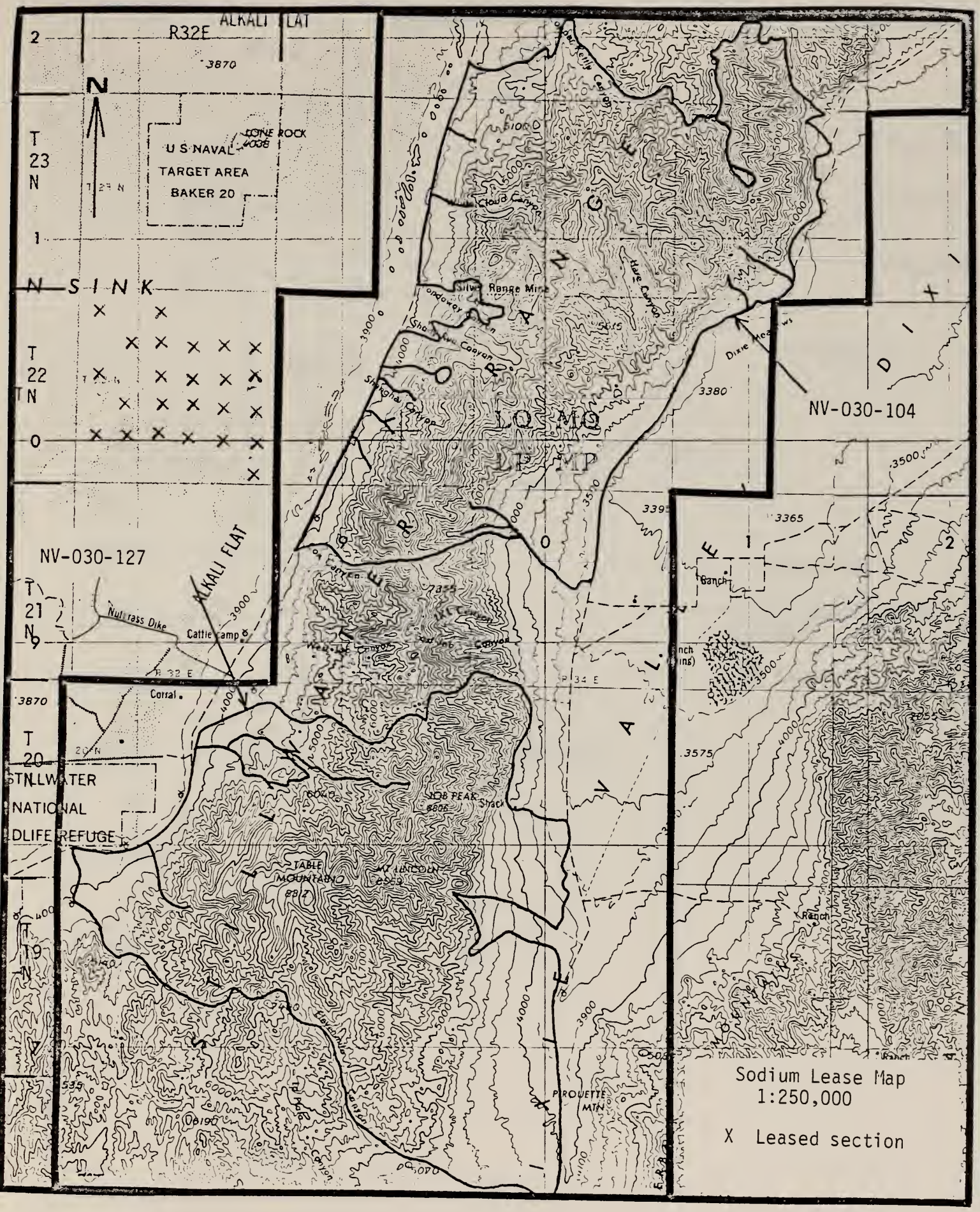
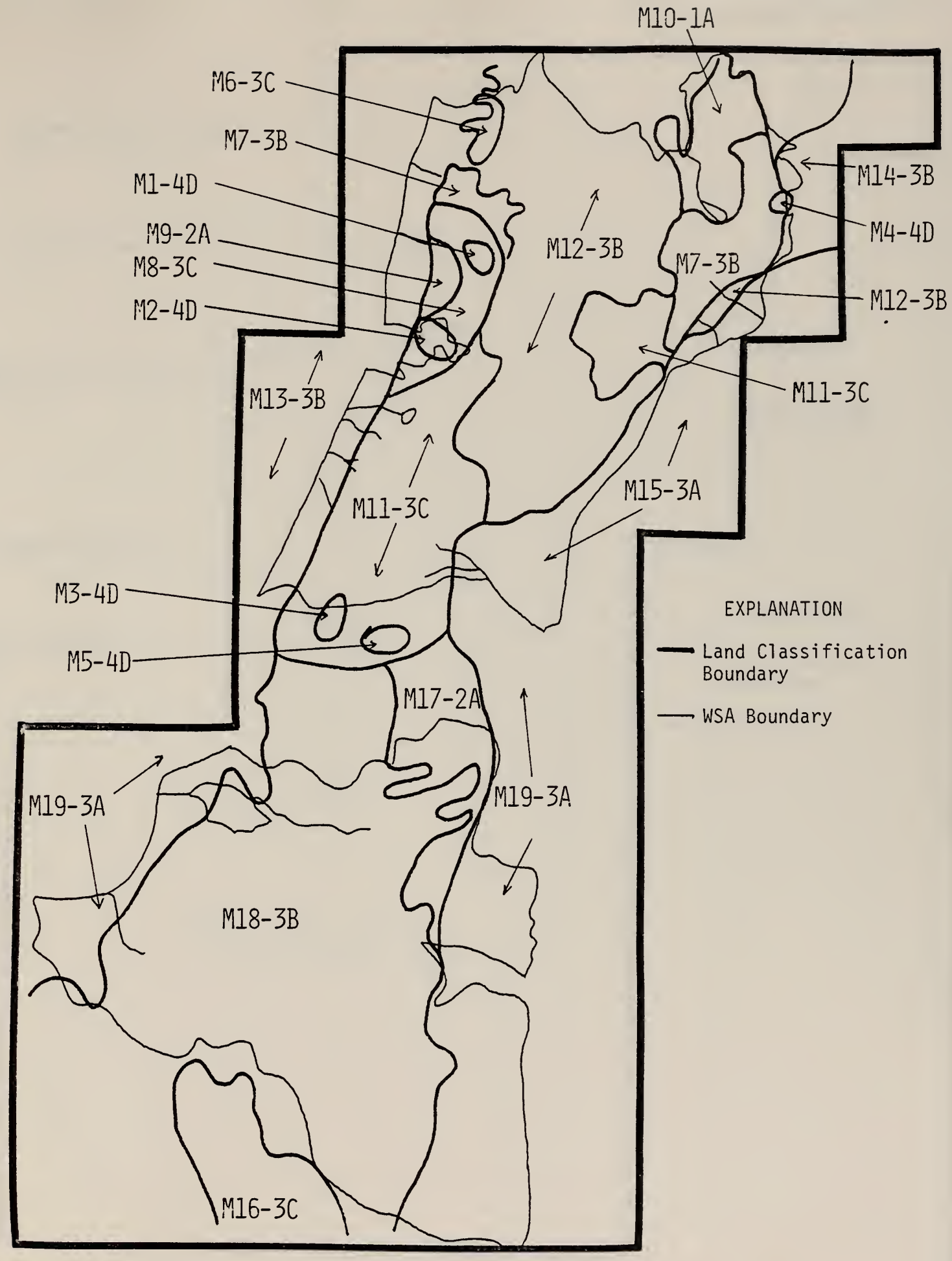


Reno Sheet

Stillwater Range GRA NV-04

Figure 2



Land Classification - Metallics

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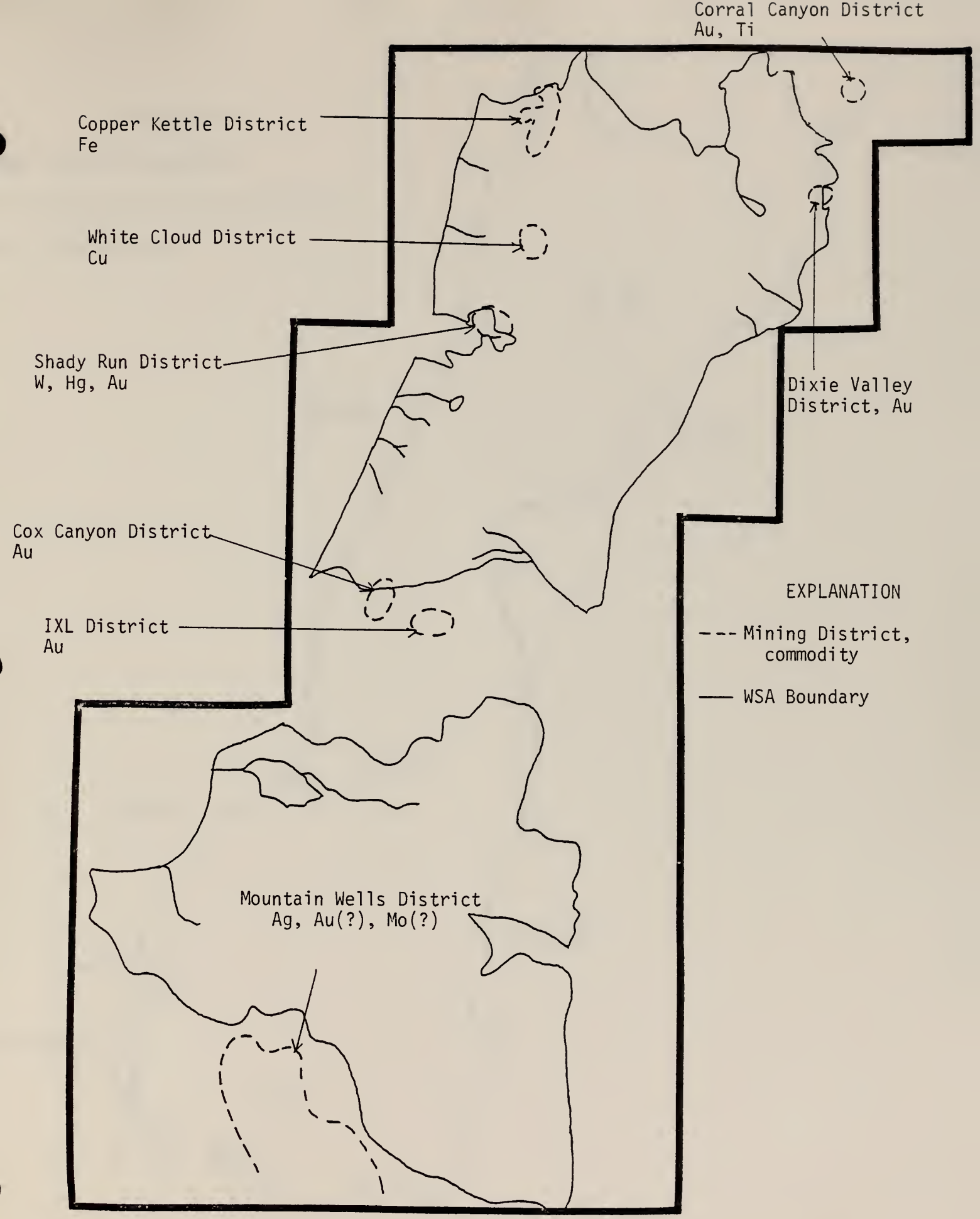
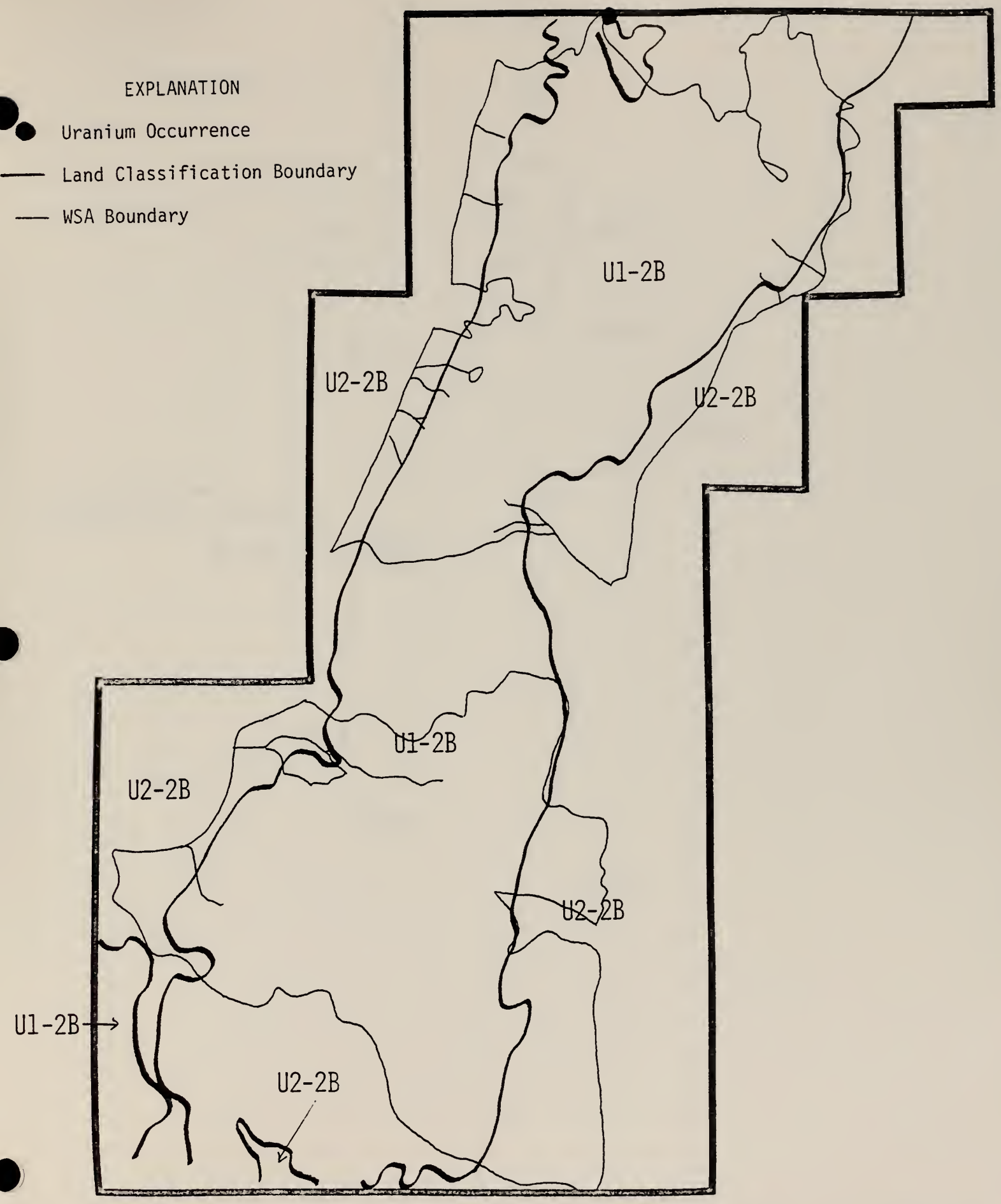
Scale 1:250,000



Mineral Occurrence Map
Metallics

Stillwater Range GRA NV-04
Scale 1:250,000



Land Classification - Mineral Occurrence Map/
Uranium

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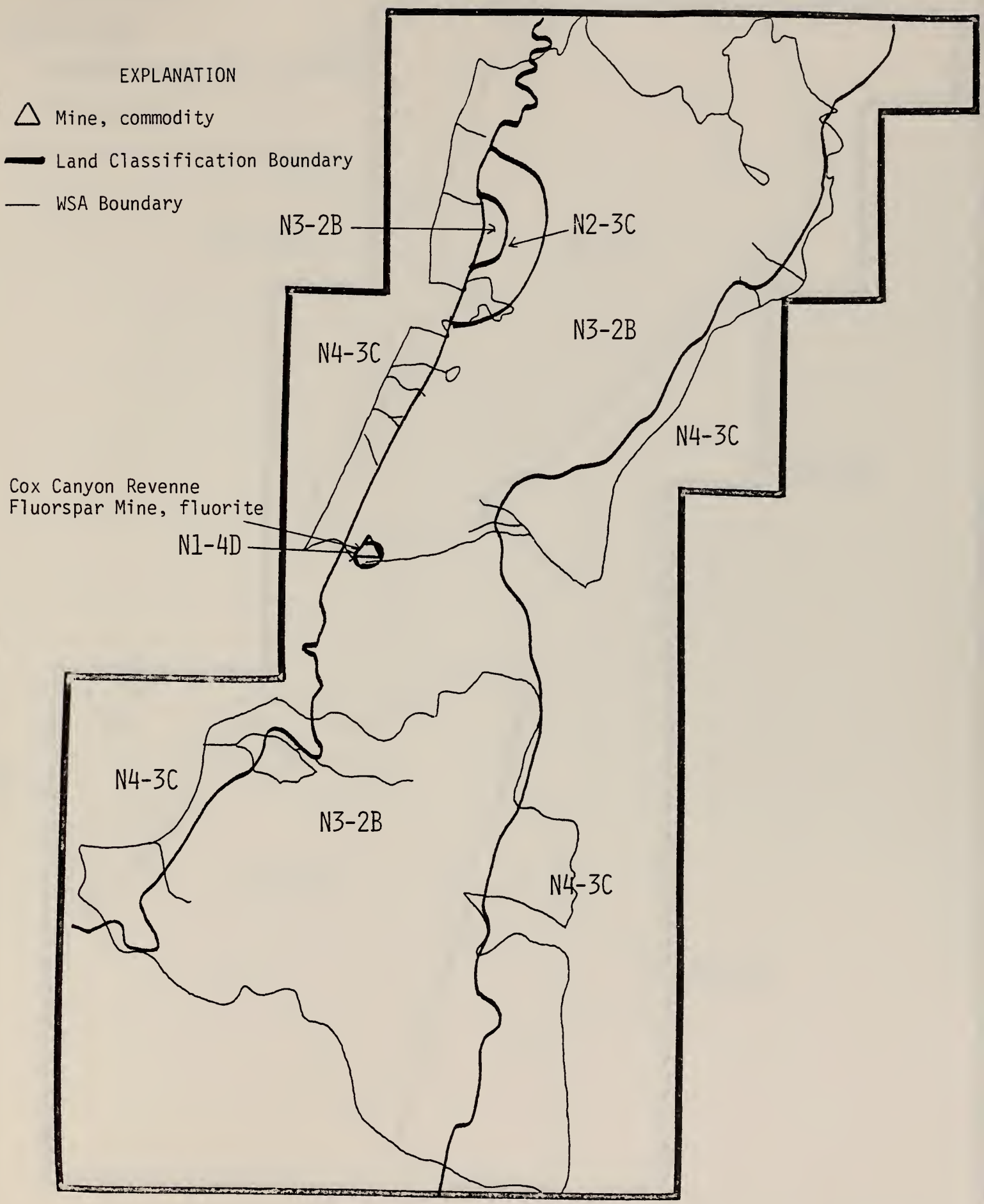

Land Classification - Mineral Occurrence Map/
Nonmetallics

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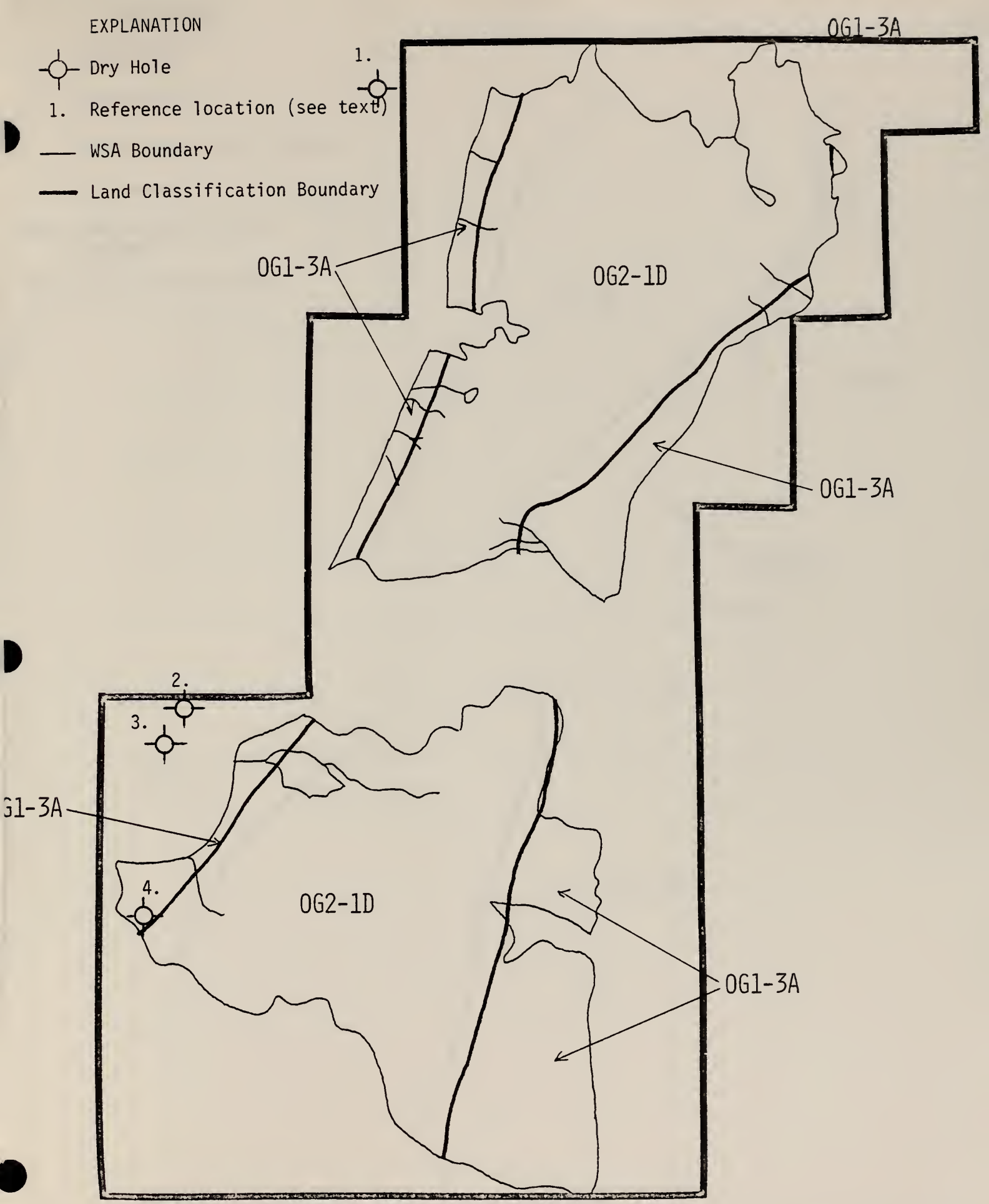

Land Classification - Mineral Occurrence Map/
Oil and Gas

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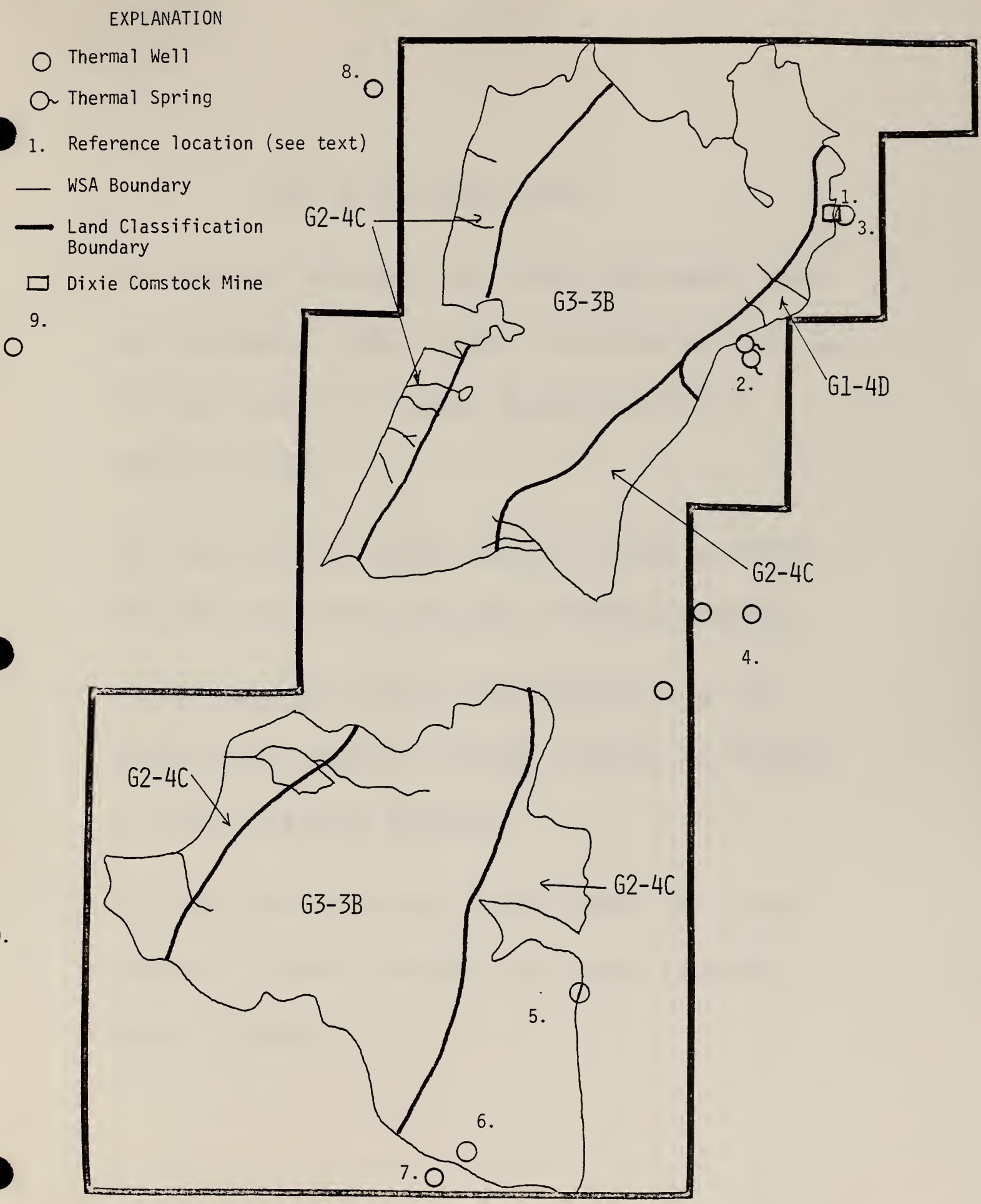

Stillwater Range GRA NV-04

Scale 1:250,000

Land Classification - Mineral Occurrence Map/Geothermal

LEVEL OF CONFIDENCE SCHEME

A. THE AVAILABLE DATA ARE EITHER INSUFFICIENT AND/OR CANNOT BE CONSIDERED AS DIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES WITHIN THE RESPECTIVE AREA.

B. THE AVAILABLE DATA PROVIDE INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

C. THE AVAILABLE DATA PROVIDE DIRECT EVIDENCE, BUT ARE QUANTITATIVELY MINIMAL TO SUPPORT TO REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

D. THE AVAILABLE DATA PROVIDE ABUNDANT DIRECT AND INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

CLASSIFICATION SCHEME

1. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES DO NOT INDICATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

2. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES INDICATE LOW FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

3. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, AND THE REPORTED MINERAL OCCURRENCES INDICATE MODERATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

4. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, THE REPORTED MINERAL OCCURRENCES, AND THE KNOWN MINES OR DEPOSITS INDICATE HIGH FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

MAJOR STRATIGRAPHIC AND TIME DIVISIONS IN USE BY THE U.S. GEOLOGICAL SURVEY

Erathem or Era	System or Period	Series or Epoch	Estimated ages of time boundaries in millions of years
Cenozoic	Quaternary	Holocene	
		Pleistocene	2-3 [1]
	Tertiary	Pliocene	12 [1]
		Miocene	26 [2]
		Oligocene	37-38
		Eocene	53-54
		Paleocene	65
Mesozoic	Cretaceous [4]	Upper (Late) Lower (Early)	136
	Jurassic	Upper (Late) Middle (Middle) Lower (Early)	190-195
	Triassic	Upper (Late) Middle (Middle) Lower (Early)	225
Paleozoic	Permian [4]	Upper (Late) Lower (Early)	280
	Carboniferous Systems: Pennsylvanian [4]	Upper (Late) Middle (Middle) Lower (Early)	
	Carboniferous Systems: Mississippian [4]	Upper (Late) Lower (Early)	345
	Devonian	Upper (Late) Middle (Middle) Lower (Early)	395
	Silurian [4]	Upper (Late) Middle (Middle) Lower (Early)	430-440
	Ordovician [4]	Upper (Late) Middle (Middle) Lower (Early)	500
	Cambrian [4]	Upper (Late) Middle (Middle) Lower (Early)	570
Precambrian [3]		Informal subdivisions such as upper, middle, and lower, or upper and lower, or younger and older may be used locally.	3,600+ [3]

[1] Holmes, Arthur, 1965, Principles of physical geology: 2d ed., New York, Ronald Press, p. 360-361, for the Pleistocene and Pliocene; and Obradovich, J. D., 1965, Age of marine Pleistocene of California: Am. Assoc. Petroleum Geologists, v. 49, no. 7, p. 1087, for the Pleistocene of southern California.

[2] Geological Society of London, 1964, The Phanerozoic time-scale; a symposium: Geol. Soc. London, Quart. Jour., v. 120, supp., p. 260-262, for the Miocene through the Cambrian.

[3] Stern, T. W., written commun., 1968, for the Precambrian.

[4] Includes provincial series accepted for use in U.S. Geological Survey reports.

Terms designating time are in parentheses. Informal time terms early, middle, and late may be used for the eras, and for periods where there is no formal subdivision into Early, Middle, and Late, and for epochs. Informal rock terms lower, middle, and upper may be used where there is no formal subdivision of a system or of a series.

GEOLOGIC NAMES COMMITTEE, 1970